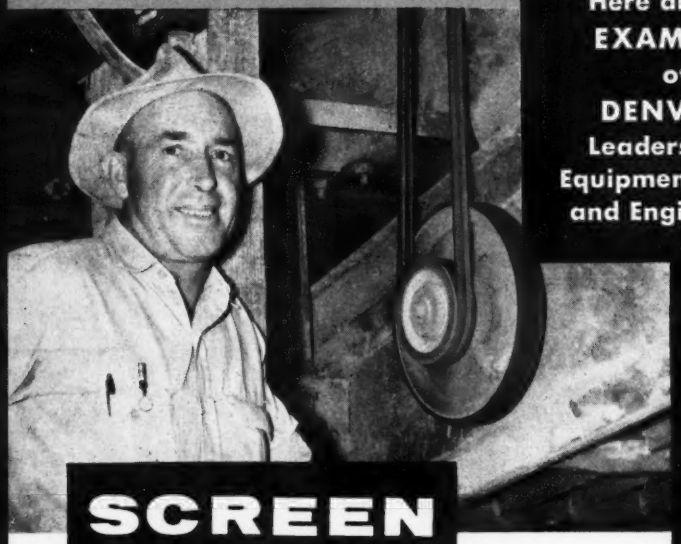
Mining

CONGRESS JOURNAL

March 1958

DENVER EQUIPMENT is Performance Proved

Here are two **EXAMPLES** of **DENVER'S** Leadership in Equipment Design and Engineering



SCREEN

Over 40,000 hours in service...

More than "just another screen." This screen has been in continuous service, 8 hours a day, 7 days a week for over 16 years—and still going strong—at the Boulder, Colorado, plant of the General Chemical Division, Allied Chemical and Dye Corp. Original bearings are still in service.

The 2-bearing design saves up to 50% HP. Circle-throw operation gives fast, accurate sizing. DENVER-DILLON Screens available to 6'x 14'. Screens in stock for Quick Delivery.

Write for Bulletin S3-B15.

JIG

Ratio of concentration from 1.5 to 1 up to 125,000 to 1...

with the Denver Mineral Jig. Distinctive rotating water valve gives unique hindered settling action. Jig handles unclassified feed, makes high ratio of recovery. Distinctive end draw off saves coarse mineral. A product of Denver's advanced engineering—produced on new, big machine tools with materials engineered for the job. Sizes 8"x 12" Simplex to 36"x 48" Duplex.

Complete details in Bulletin J2-B10.

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DENVER EQUIPMENT CO.

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Mining

CONGRESS JOURNAL

MARCH, 1958

VOLUME 44 NUMBER 3

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FRONT COVER: Shaft sinking for a new potash mine in the Carlsbad district was completed in December 1957. The man on the left, with the control box, operates motors at shaft collar which control the clamshell.

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Circulation
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Published Monthly. Yearly subscriptions, United States, Canada, Central and South America, $3.00. Foreign, $5.00. Single copies, $0.30. February Annual Review Issue, $1.25. Entered as Second-class Matter, January 30, 1915, at the Post Office at Washington, D. C.

Member Audit Bureau of Circulation

Indexed regularly by Engineering Index, Inc.

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Are you sure you're blasting on the most profitable

KNOW YOUR

FREE,

BLASTING COST CHART
BLASTING COST CHART
DATE:
LOCATION:
LOADING PATTERN
BLASTING COST CHART
Date of Blast, or period covered
SECONDARY BREAKAGE
OPERATING COSTS
1. Labor and supervision
2. Cost of equipment (use amortization depreciation schedule)
3. Cost of power or fuel for equipment (for dryers, compressors, etc.)
MATERIALS AND SUPPLIES
1. Cost of secondary explosives
2. Blasting materials (detonators, fuse, wire or other expended materials)
3. Drill bits
MAINTENANCE, REPAIR AND REPLACEMENT (either owned or procured)
1. Labor
2. Parts and supplies (including replacement items)
TOTAL SECONDARY BREAKAGE COST
Divide by Total Tons or Yards =
Secondary Breakage Cost Per Ton or Yard
DIGGING, HAULING AND CRUSHING
OPERATING COSTS
1. Labor and supervision
2. Cost of equipment (shovels, trucks and primary crusher only)
(use amortization depreciation schedule)
3. Power or fuel
MAINTENANCE AND REPAIR (either owned or procured)
1. Labor
2. Parts and supplies
TOTAL DIGGING, HAULING AND CRUSHING COSTS
Divide by Total Tons or Yards =
Digging, Hauling, Crushing Cost Per Ton or Yard
MISCELLANEOUS
(Include here all other costs, such as: insurance for the blast or general adm-
inist, and other expenses not included above)
TOTAL MISCELLANEOUS COST
Divide by Total Tons or Yards =
Miscellaneous Costs Per Ton or Yard
TOTAL ROCK COST
TOTAL ROCK COST PER YARD OR TON
PRIMARY BLASTING
OPERATING COSTS
1. Labor and supervision (include handling and loading of explosives and
cleaning plus any clean-up required after blast)
2. Cost of equipment (use amortization depreciation schedule)
3. Power and fuel (for trucks and equipment used in handling and clean-up)
MATERIALS AND SUPPLIES
1. Primary high explosives or blasting agent (include fuel oil if used)
2. Blasting materials (primers, boosters, detonating devices, fuse, detonating
cord or other expended materials)
MAINTENANCE, REPAIR AND REPLACEMENT (owned or procured)
1. Labor
2. Parts and supplies (including replacement items)
TOTAL PRIMARY BLASTING COST
Divide by Total Tons or Yards =
Primary Blasting Cost Per Ton or Yard
BLASTING COST CHART
DATE:
LOCATION:

basis?

BLASTING COSTS!

simplified computing method—developed by Atlas —quickly gives you true, complete cost picture

Explosives costs alone don't always determine the value of blasting. The explosives you use have a direct effect on cost of drilling, digging, hauling and crushing. When you have all the cost figures at hand, you can eliminate guesswork—plug profit leaks wherever they occur, and wind up money ahead!

Atlas can show you how, with this new Blasting Cost Chart. It's simple to use—involves no extra bookkeeping. But what a difference it makes in knowing your true profits and how to protect or improve them!

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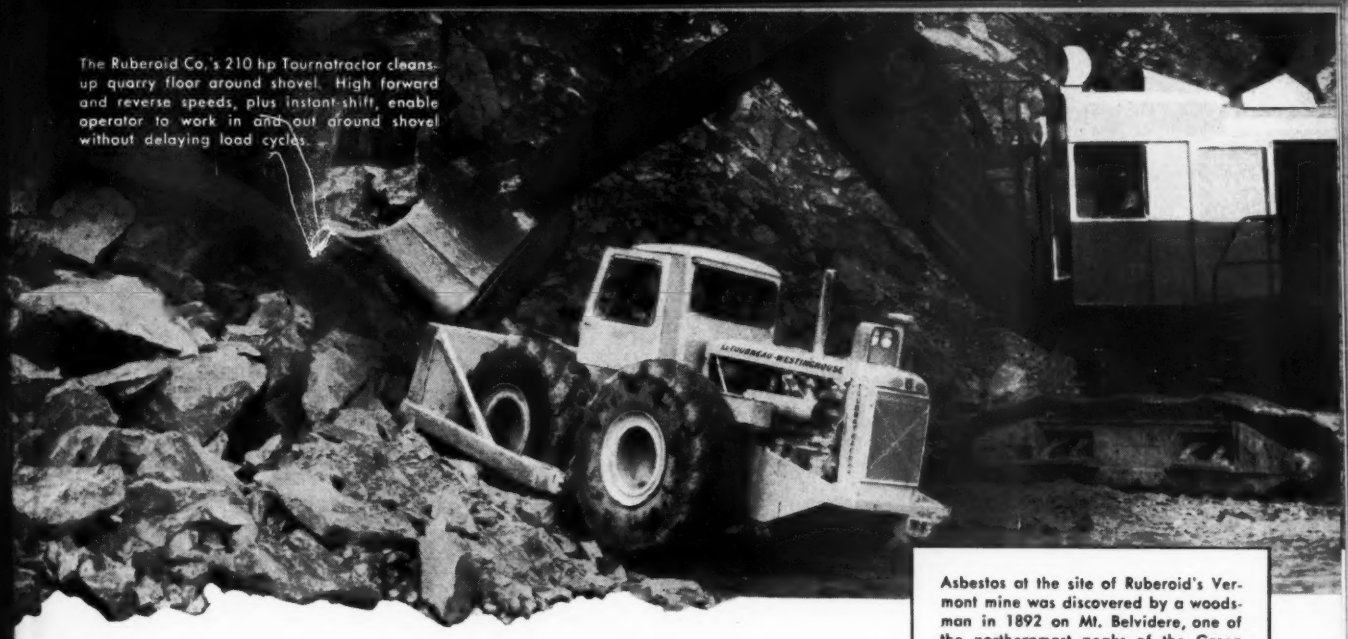


The Ruberoid Co.'s 210 hp Tournatractor cleans-up quarry floor around shovel. High forward and reverse speeds, plus instant-shift, enable operator to work in and out around shovel without delaying load cycles.

Asbestos at the site of Ruberoid's Vermont mine was discovered by a woodsman in 1892 on Mt. Belvidere, one of the northernmost peaks of the Green Mountain chain. Today — employing more than 200 men — operations are being carried on from the 1,500-ft. level down to the 1,050-ft. level, across a width of about 3,000 ft. Asbestos-bearing ore is blasted loose from the quarry face and hauled to crushers. After a number of steps of crushing, ore is milled to remove valuable fiber. Asbestos fiber from the Vermont mine has a variety of uses in fireproofing materials, plastics, paper, millboard and, most important, many long-lasting, maintenance-free building materials.

Cutting costs at largest U.S. asbestos mine...

one rubber-tired tractor handles clean-up around 4 scattered shovels... shuttles back and forth to level overburden dump

At their 3,000-acre quarry on Mt. Belvidere, near Lowell, Vermont, The Ruberoid Co. of New York is extracting asbestos-bearing rock around the clock, winter and summer. Men and machines are literally moving huge sections of the mountain from pit to processing plant. The latest, most modern equipment and methods are employed. One rubber-tired 210 hp Tournatractor® adds to the efficiency of this operation by handling all clean-up around shovels and dump. This LeTourneau-Westinghouse tractor is on call constantly, 24 hours a day, every day of the year.

Rubber-tired tractor drives to scattered jobs fast. Tournatractor handles clean-up assignments at the Vermont mine 24 hours a day ... year-around, through winter and summer.

Dozes at speeds to 3.3 mph

Tournatractor's primary task is cleaning-up around the mine's 4 large electrically-controlled shovels. Keeping this area of the quarry floor smooth and free of loose rock, helps lower tire maintenance costs on haulers, and permits faster shovel operation. With its dozer blade, Tournatractor pushes big rock to bench toe at speeds to 3.3 mph; return is made in high reverse, 7.2 mph.

Travels mile in minutes

In order to handle maintenance on overburden dump, Tournatractor must travel one mile from the "upper mine". It takes only a few minutes for this fast-stepping, rubber-tired tractor to drive to the dump. It goes right to work... completes the job and quickly returns to quarry floor. Tournatractor makes this 2-mile round-trip a number of times each day. Another assignment is to clean-up after blasts. Also, unit occasionally helps pioneer roads into new areas of operation. Wherever Tournatractor goes, its big, low-pressure tires cross electric-cables, air-drill hoses and blacktop.

High-speed operation with low maintenance

On shovel clean-up, owner-verified reports show Tournatractor outproduces conventional tractors 2-to-1. Users find that Tournatractor works and travels faster, gets more work done in less time. Owners find, also, that tires cost less to maintain... eliminate the need for expensive track repairs or time-consuming track assembly lubrications. Why not let us show you how Tournatractor can help *you* increase production and lower operating costs? Call or write for a demonstration.

CT-1669-MJ-1

LETOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

When you need a centrifugal dryer,

you want One Machine for the Entire Job

This Means a REINEVELD Fine Coal Dryer...

- The Reineveld has greater flexibility and accepts any particle size of feed **from 3/8" all the way down to 0"** without requiring prior classification or desliming.
- The superior construction of the Reineveld permits higher G's with resulting low cake moisture and greater capacity.
- An integral distributor accelerates the feed in the direction of rotation and reduces degradation.
- The sturdy Reineveld is designed to operate at maximum efficiency and maintains uniformity of operation, even with intermittent feed.
- All this plus the low first cost of the Reineveld adds up to making it the most efficient centrifuge operating consistently at lowest overall cost!

For complete details, consult with a Heyl & Patterson sales engineer.

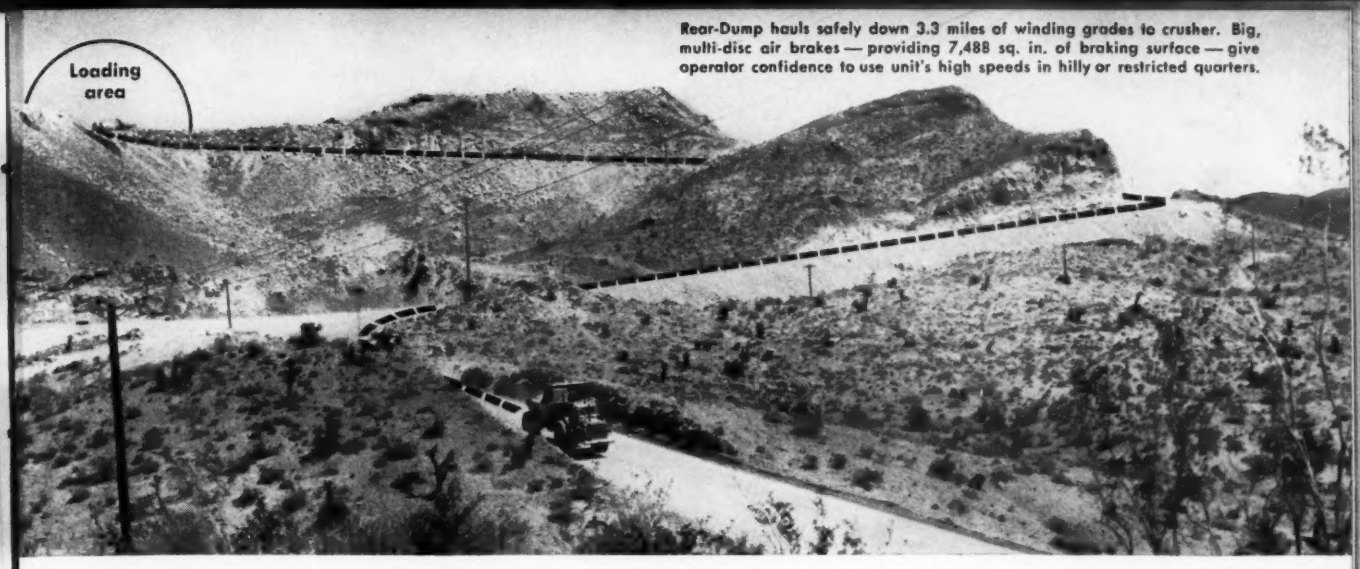
Reinevelds are used by many of the leading coal companies. Among the six top-ranked coal producing groups, four are using a total of 47 REINEVELD FINE COAL DRYERS

GROUP OR COMPANY	1956 Tonnage	% Change 1955 to 1956
Pittsburgh Consolidation Group* . .	31,724,380[1]	+ 13.3
U. S. Steel (c)	22,889,712[10]	– 9.0
Peabody Group*	21,698,493[6]	+ 59.9
Island Creek*	14,782,405[4]	+ 44.9
Eastern Gas & Fuel*	10,472,274[3]	+ 12.5
Pittston Group*	10,391,461	+ 28.
[illegible] (c)	9,507,[illegible]	

Excerpt from Keystone Coal Buyers' Manual

Heyl & Patterson INC.

55 FORT PITT BLVD., PITTSBURGH 22, PA., COurt 1-0750



Rear-Dump hauls safely down 3.3 miles of winding grades to crusher. Big, multi-disc air brakes — providing 7,488 sq. in. of braking surface — give operator confidence to use unit's high speeds in hilly or restricted quarters.

On 6.6-mile cycle . . .

two 35-ton haulers move 2,352 tons limestone daily

A large California cement plant produces 5 million barrels of cement a year. To meet today's stepped-up demands, the company is mining limestone at several pits at Oro Grande — 24 hrs. a day, 5 days a week. Important tools in their hauling fleet are two LeTourneau-Westinghouse 35-ton B Tournapull® Rear-Dumps. Here's how these high-production units perform:

Haul up and down average 3 to 4% grades

35-ton B Rear-Dumps are loaded to heaped capacity by a 2½-yd. shovel. Units then haul material 3½ miles to crushing plant. On the haul, Tournapulls travel up 4% grade for 1/5 mile, and then over an average 3 to 4% down-grade for 3⅓ miles. Despite waiting time at shovel and plant hopper, company records show the two Rear-Dumps average 98 tons (2.8 loads) per hour. At this rate, units haul 784 tons per 8-hr. shift . . . or 2,352 tons daily.

"Maneuverable, easy to maintain"

Quarry Superintendent commented, "I like the 'B's' . . . they're maneuverable and easy to maintain. And on steep downhill hauls we have to have their sure, safe brakes." Added one of the operators, "The B Rear-Dump is easy to control. We do our own lube and it takes me only 5 minutes per machine."

Use rubber-tired tractor for clean-up

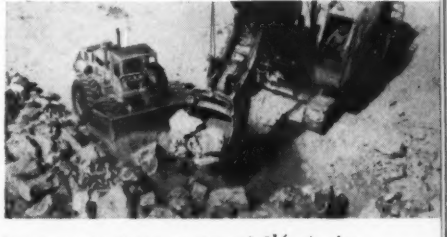
The company uses another LeTourneau-Westinghouse tool to speed pit operations. It is a high-speed 210 hp Tournatractor®. This rubber-tired tractor shuttles around the multiple pit operations fast — cleans up around shovels and blast area, and maintains haul roads. On blast clean-up, Tournatractor completes the job in ⅓ the time it used to take with a crawler tractor.

Cut operating costs

Any pit operation shows more production . . . more profit . . . when it has modern high-speed equipment in its fleet. Why not arrange for a demonstration of LeTourneau-Westinghouse Rear-Dump, and/or Tournatractor? Call or write for complete details. No obligation.

BRCT-1540-QMJ-1

Big B Rear-Dump empties 35-ton load of limestone into hopper. Electric hoist motor — operated by electric switch on dashboard—lifts bowl at any desired angle for slow, precision feeding.

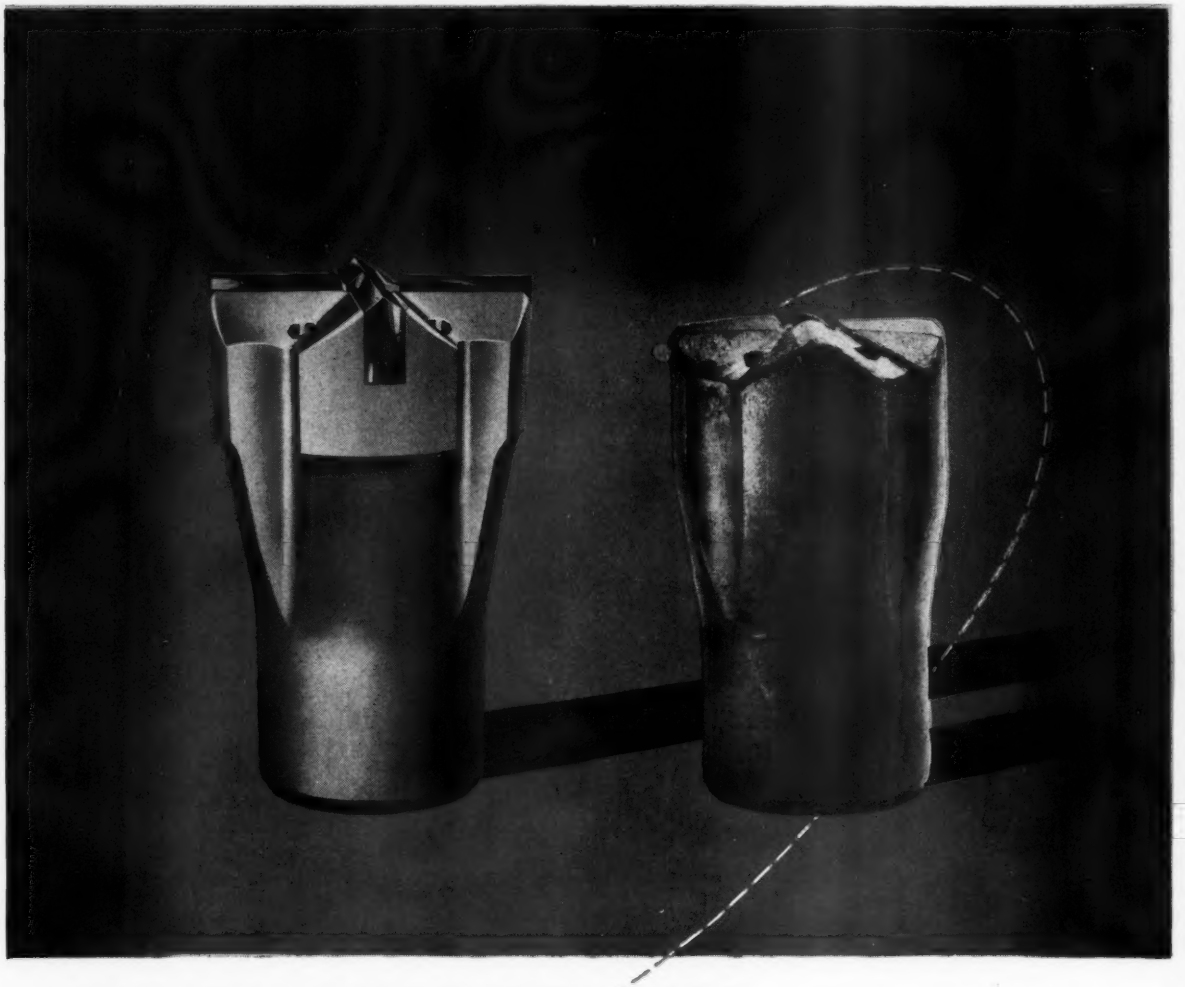


Tournatractor cleans up around 2½-yd. electric-power shovel at California limestone pit. Rubber-tired tractor drives job-to-job fast — crosses air-drill hoses, electric cables, railroad tracks, pavement, without damage. Operator says: "Tournatractor is fast . . . beats a crawler to keep pits and haul roads clean."

LETOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit



THIS JOY BIT DRILLED 1000 *extra feet of hole*

The real test of any tungsten carbide bit is—*how far does it drill?* The pictures above show a Joy bit before and after it drilled over 1900 feet of hole.

On a New England dam job, all other tungsten carbide bits had averaged 950 feet. Joy bits doubled this footage . . . averaged 1900 feet . . . gave the contractor a 2 to 1 advantage. (Particulars on request.)

You, too, can boost your bit footage and cut costs substantially with Joy Tungsten Carbide bits. Their offset wings, deep-slotted chipways, precision-milled threads, new brazing technique, long-lasting carbides and special alloy steel bodies make the difference. These features assure you of longer bit life and lower cost per foot of hole.

Get complete information from ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** *In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

WSW M6821-198

YOU'LL FIND YOUR BIT SIZE IN THIS CHART

SHOULDER DRIVE	BOTTOM DRIVE	TAPER SOCKET
1½"	2½"	1¼"
1⅝"	2¾"	1⅜"
1¾"	3"	1½"
1⅞"	3¼"	1⅝"
2"	3½"	1¾"
2⅛"	4"	
2¼"	4½"	
2⅜"	5"	
2½"	5"	
2¾"	5½"	
3"	6"	
3½"		
4"		
4½"		

NOTE: Orange shade indicates x-type.
Black shade indicates 6 point rose design.
Others are cross type.

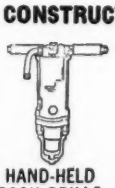
WRITE FOR FREE BULLETIN 198-3

JOY EQUIPMENT FOR MINING . . . QUARRYING . . . CONSTRUCTION

PORTABLE COMPRESSORS

WAGON DRILLS

TUNGSTEN CARBIDE ROCK BITS



HAND-HELD ROCK DRILLS

Rugged Rock Work

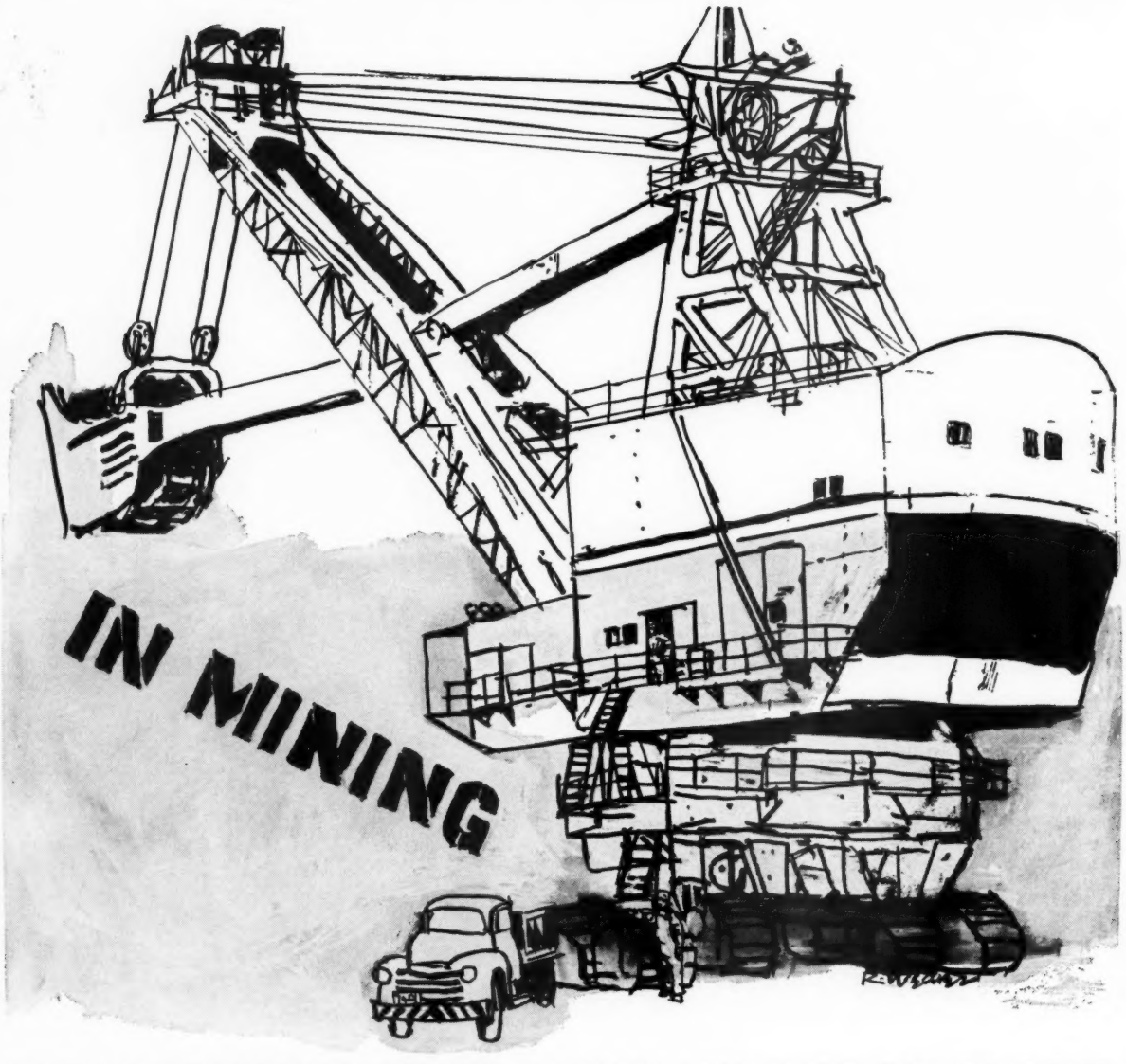
Hard, abrasive rock is the supreme test of a power shovel's ability. Eight Marion 4161's like this one, with 5-yard dippers, load broken rock around the clock in an open pit copper mine of southwestern New Mexico. Each machine handles up to 5000 tons of waste rock and ore in an eight-hour shift.

Marion's extensive line includes the 1½-yard 362 shovel, shown here loading bank-run sand and gravel at the pit of an Ohio firm. Modern heavy-duty construction of this machine matches that of larger Marions.

CONSULT MARION MINING SPECIALISTS
for lowest costs on your property!

MARION POWER SHOVEL COMPANY—MARION, OHIO, U. S. A.

A Division of Universal Marion Corporation



NOTHING TRANSMITS POWER AT SUCH LOW COST FOR SO LONG AS ROEBLING ROYAL BLUE WIRE ROPE. No means of transmitting power can be compared—on a cost basis—with Royal Blue, the strongest wire rope you've ever used. Meeting stringent service demands is a function fulfilled by Royal Blue in many ways: unimpaired flexibility, great resistance to shock, abrasion and impact—a plurality of qualities that make for singularly long service life. For further details on "length through strength," communicate with Wire Rope Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

ROEBLING

Branch Offices in Principal Cities
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ROEBLING
ROYAL-1105-BLUE
DESIGN
FOR WIRE ROPE
Its ready adaptability is evident wherever power is transmitted. It conforms to unique design requirements. Use wire rope to transmit power.

TO MAKE THE
MOST OF
EVERY BLAST
...USE
CYANAMID
EXPLOSIVES!

You achieve optimum results when you rely on Cyanamid explosives and techniques!

That's because Cyanamid specializes in helping you *engineer* your blasting. Precise control...selecting the most effective techniques...economy...safety ...careful planning...highest quality explosive materials – all these factors must be combined to assure greater blasting productiveness.

Trained Cyanamid representatives will be glad to assist you in putting these techniques into effective practice. Cyanamid plants and magazines are strategically located to give you fast and efficient delivery.

CYANAMID

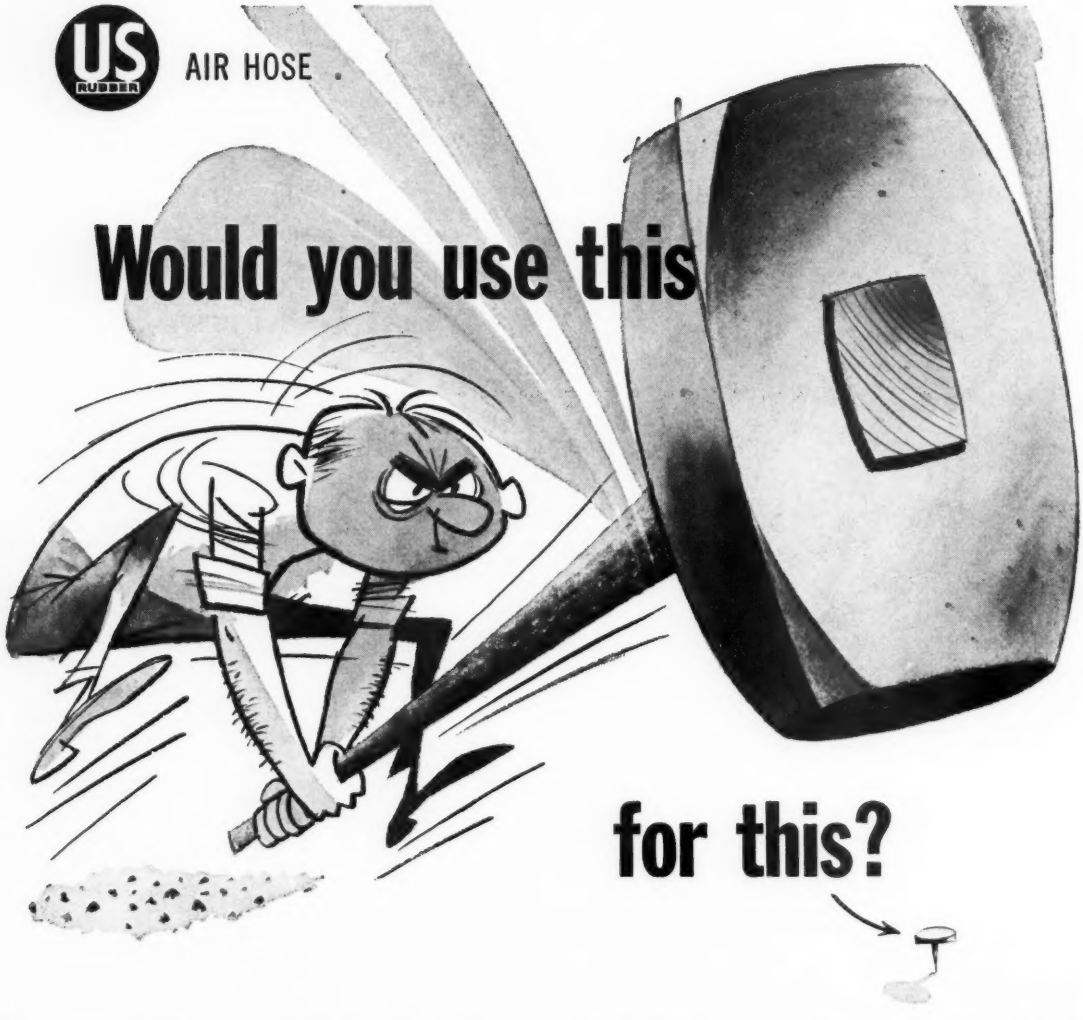
AMERICAN CYANAMID COMPANY
Explosives Department
30 Rockefeller Plaza, New York 20, New York

DISTRICT SALES OFFICES: St. Louis, Missouri; New York City, New York; Latrobe, Pennsylvania; Pottsville, Pennsylvania; Scranton, Pennsylvania; Dallas, Texas; Salt Lake City, Utah; Bluefield, West Virginia

THE CYANAMID LINE: High Explosives • Permissibles • Seismograph Explosives • Blasting Agents • Blasting Powder • Blasting Caps • Electric Blasting Caps • Blasting Accessories

US RUBBER AIR HOSE

Would you use this



for this?

Then why pay extra for heavyweight, muscle-bound air hose, when U.S. Rubber Air Hose is easier to handle, more flexible, and withstands higher working pressures...at lower end cost.

When you're on a tight budget and a tight schedule, there's no sense in throwing dollars away buying overweight, hard-to-handle air hose. Such hose—with excessive, unnecessary plies—is out of date, will slow you down, and leave you out of pocket.

Now, thanks to "U.S." engineering, you get the optimum balance in air hose—easier to handle *and* at the same time tougher and less expensive. What's more, U.S. Air Hose handles higher working pressures than the conventional air hose you might be using.

Every hose in the complete "U.S." line is designed to give maximum service, even under unreasonable demands. Take advantage of the skill and long experience of "U.S." Hose technicians, plus "U.S." research and production facilities. Get U.S. Air Hose at your local authorized "U.S." Hose Distributor, or write us at Rockefeller Center, New York 20, New York. In Canada: Dominion Rubber Co., Ltd.

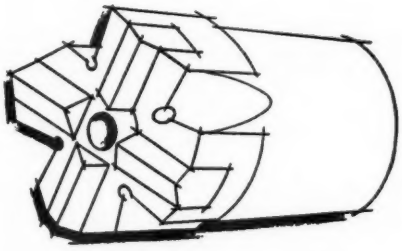
US RUBBER

Mechanical Goods Division

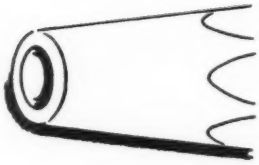
United States Rubber

See things you never saw before. Visit U.S. Rubber's New Exhibit Hall, Rockefeller Center, N.Y.

NOW!



REMOVABILITY



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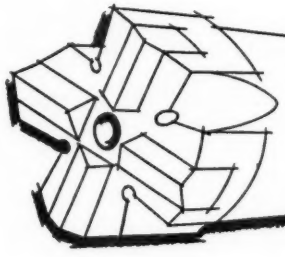


ONE-PIECE STRENGTH

IN AN AIR-LEG BIT!

AIR-LEG drillers, now you can have your cake and eat it, too. The new Timken® tapered socket bit is removable—yet gives you the strength of one-piece steels. The secret is the taper. It gives you all the advantages of removability with a strong, secure union.

Here are a few of the plusses you get with the Timken tapered socket but can't get with intraset steels because they're not removable.

1. You don't have to throw away the drill steel just because the carbides wear out. You do with an intraset steel.

2. You carry just a pocketfull of bits into the mine. Try putting an intraset steel in your pocket.

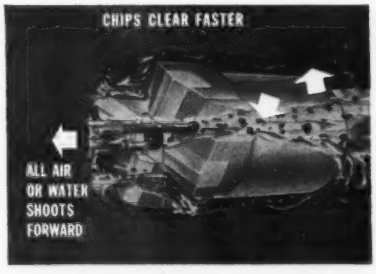
3. You can quickly change bit gage sizes using the same steel. With an intraset steel, you have to change a whole steel.

4. You don't have to lug the whole steel back to the shop to resharpen the cutting edges. You do with a 4-point intraset steel.

5. You get four carbide cutting edges. You get only two with a chisel intraset steel.

And you get further economies because the Timken tapered bit clears chips faster. The picture at right shows you how. New special-analysis carbide inserts give superior wear-resistance with added shock-resistance. And they can be reconditioned many times.

For removability *and* strength, use the air-leg bit of the future. Write for our free brochure. The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. Cable address: "TIMROSCO".



CHIPS CLEAR FASTER because 1) new five front holes shoot water or air directly against the rock face and 2) new deeper, wider wing clearance lets chips wash back faster.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

AVAILABLE NOW!

THE AIR-LEG BIT OF THE FUTURE

Making enviable record for Capacity-Loading

WHALEY "AUTOMAT"

BACKED BY 50 YEARS OF MECHANICAL LOADER BUILDING EXPERIENCE!

WHALEY "AUTOMATS" like the ones pictured have been called "The Workhorse of the Mining Industry." An appropriate term based on the "Automat's" enviable record for capacity-loading (Maximum 766-Tons in one shift in coal). This vitality through three-shift operations results from the machine's mechanical reliability. For a fact, it has been claimed the Whaley "Automat" is designed and built to capacity-load forever. When you consider the job being done today by "Automats" 20-years old and more, not just in soft coal, but in tough entry driving, for rock and slate handling, and hard rock tunneling, this durability at low upkeep makes the Whaley "Automat" the best loading machine investment for you!

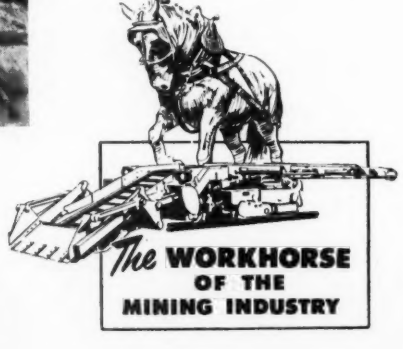
Need your "Automat" track or crawler-mounted?

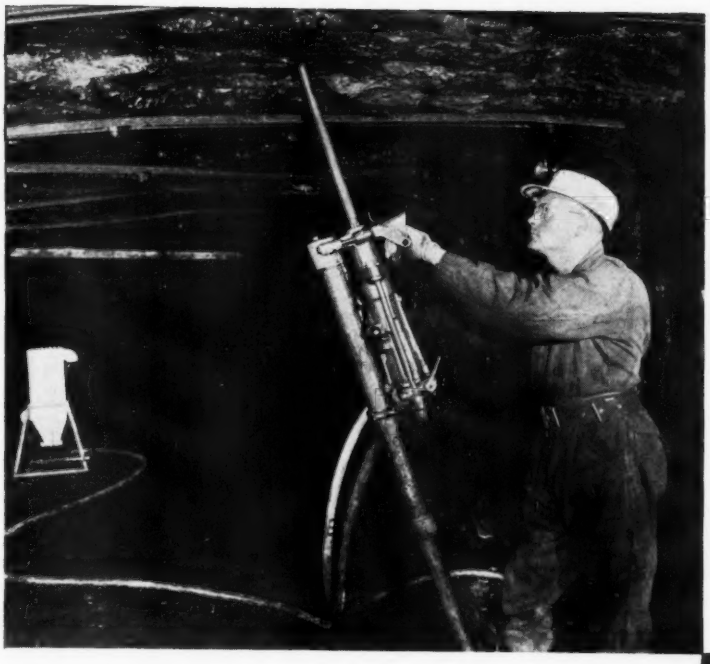
The crawler-mounted "Automat" offers you all the advantages of the track-mounted machine. Too, if you are presently equipped with "Automats," conversion to our Hydraulic Drive is available. One leading mine converted four "Automats." One thing for which you can be certain, be it track or crawler-mounted, for general work in coal, rock or ore, the YEARS HAVE PROVED there is no underground loader that can capacity-load continuously like the Whaley "Automat." Write us for complete literature and information. *MYERS-WHALEY COMPANY — also machine re-conditioners and rebuilders.*

MYERS-WHALEY

"OLDEST BUILDERS OF UNDERGROUND LOADING MACHINES"

MYERS-WHALEY COMPANY, KNOXVILLE, TENNESSEE, USA





new

from

Ingersoll-Rand

5-706 11 Broadway, New York 4, N. Y.

It's the sensational

VACUJET ROOF BOLTING DUSTLESS STOPER

with built-in JET SUCTION
and PRESSURE DISCHARGE

In the new RP38E VACUJET dustless stoper, Ingersoll-Rand has perfected the first practical solution to the problem of dust control for roof bolting and other up-hole drilling operations. It's the *only* stoper that offers you all these important advantages.

Strong Suction Power — vacuum-producing jet ejector built into drill backhead. Can even drill horizontal holes!

Dust Discharged Under Pressure — to a distance of up to 25 ft from drill. Uses ordinary air hose.

Low-Cost Dust Collector — a simple filter and receptacle is all that's required. Even a canvas bag will do.

Quieter Operation — no unnecessary ear-splitting whine or howl in dust collection.

Highest Drilling Speed — because stronger vacuum and larger dust ports assure non-clogging operation.

Lower Bit, Rod and Shop Costs — tapered bit and rod connections eliminate need for furnaces, threading and forging equipment.

For the complete story on this revolutionary new VACUJET stoper, call your I-R man or send today for Bulletin No. 4195.

COMPRESSORS • CARSETS BITS • ALLOY RODS • HYDRA-BOOM JUMBOS HOSE • JACKDRILLS • IMPACTOOLS

2 new ALLIS-CHALMERS DIESELS

D-516
131 brake hp at 1800 rpm

D-344
88 brake hp at 1800 rpm

. . . with

DO-MORE POWER

THEY'RE ALIVE WITH WORK-POWER AT SPEEDS YOU CAN USE!

These two completely new Allis-Chalmers diesels give you real *Do-More Power* — high-torque power that puts maximum turning effort on a shaft at the "bread and butter" speeds you actually use. They are smooth, steady, responsive to give you more profitable performance wherever you use them.

Follow-through combustion results in top fuel economy, lower operating costs.

BRIEF SPECIFICATIONS	D-344	D-516
Piston displacement, cu in	344	516
Bore and stroke	$4^{7}/_{16} \times 5^{5}/_{16}$	
Cylinders	4	6
Maximum bare engine horsepower (at 1800 rpm)	88	131
Power unit horsepower (at 1800 rpm)	79	122
Maximum torque at rpm	278 @ 1000	392 @ 1300
Fuel	No. 2 Comm. Diesel	
Types	Fan to flywheel engines Open or closed power units.	

Strength flows from end to end through husky, forged steel crankshaft.

Positively controlled cooling and lubricating works wonders with efficiency and engine life.

4-cycle simplicity fortifies your work-power, gives you more for your engine dollar.

Built-in safeguards provide protection, help assure dependable performance.

Ruggedness throughout means bonuses in long life, more operating hours per dollar.

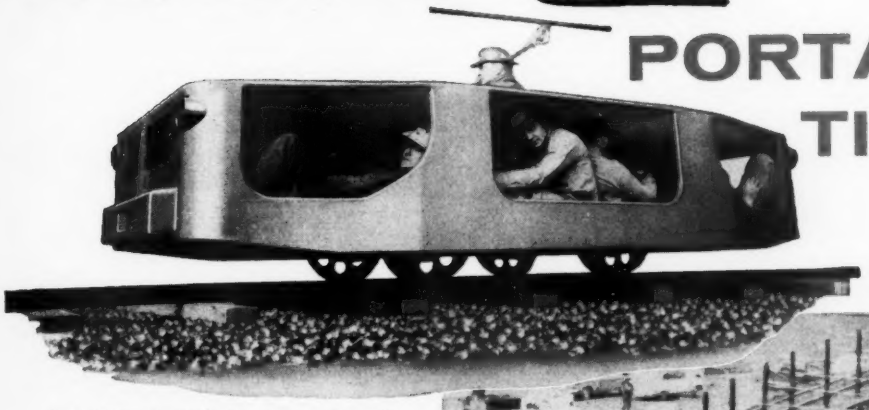
Call your Allis-Chalmers engine dealer. Get the complete story on these and other Allis-Chalmers *Do-More Power* engines — 9 to 516 horsepower; operating on diesel fuel, gasoline, LP or natural gas.

ALLIS-CHALMERS,
ENGINE - MATERIAL HANDLING DIVISION,
MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

BC-13

You, too, can *reduce* PORTAL TIME *up to 50%!*

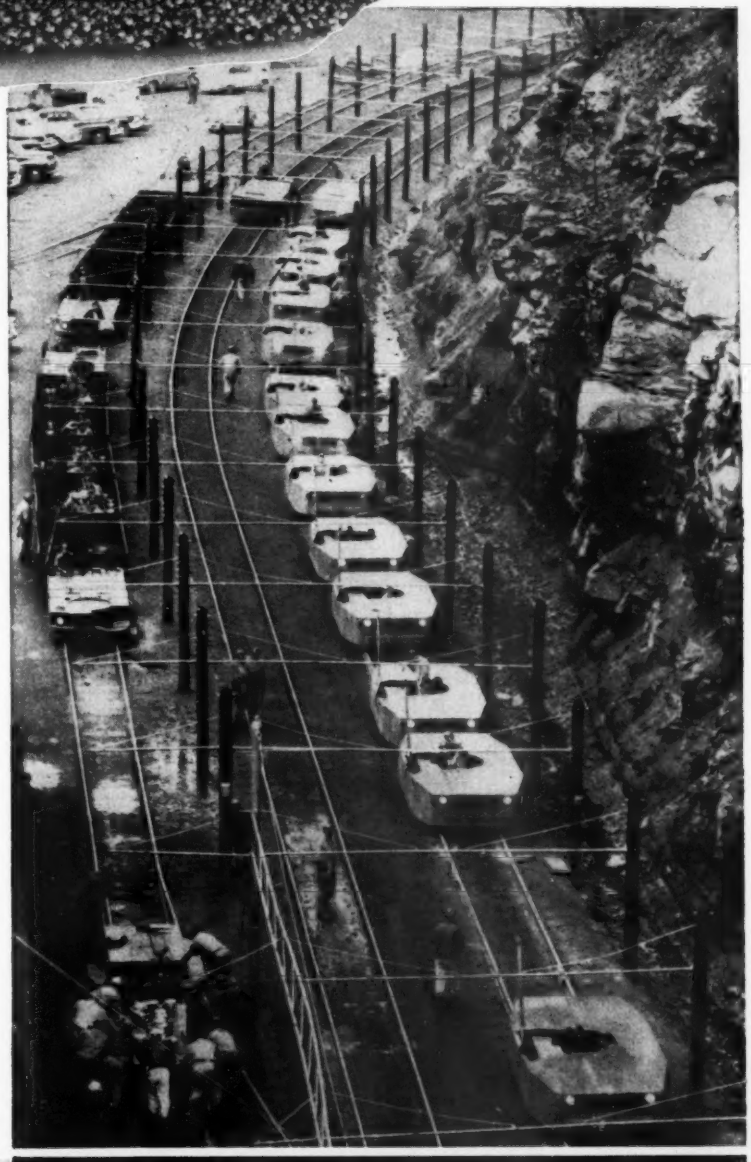


TJ5 Mine Portal Bus, "Low Type"

Lee-Norse Self-Propelled MINE PORTAL BUS

Factual performance records prove that the Lee-Norse Mine Portal Bus can effect up to 50% savings in portal time . . . savings that result in more man hours at the section face . . . increased tonnage at a reduction in overall cost per ton.

Built in low and high types to suit your haulage road, the Mine Portal Bus features complete safety —two separate braking systems . . . split-roof design that allows operator full vision at all times.

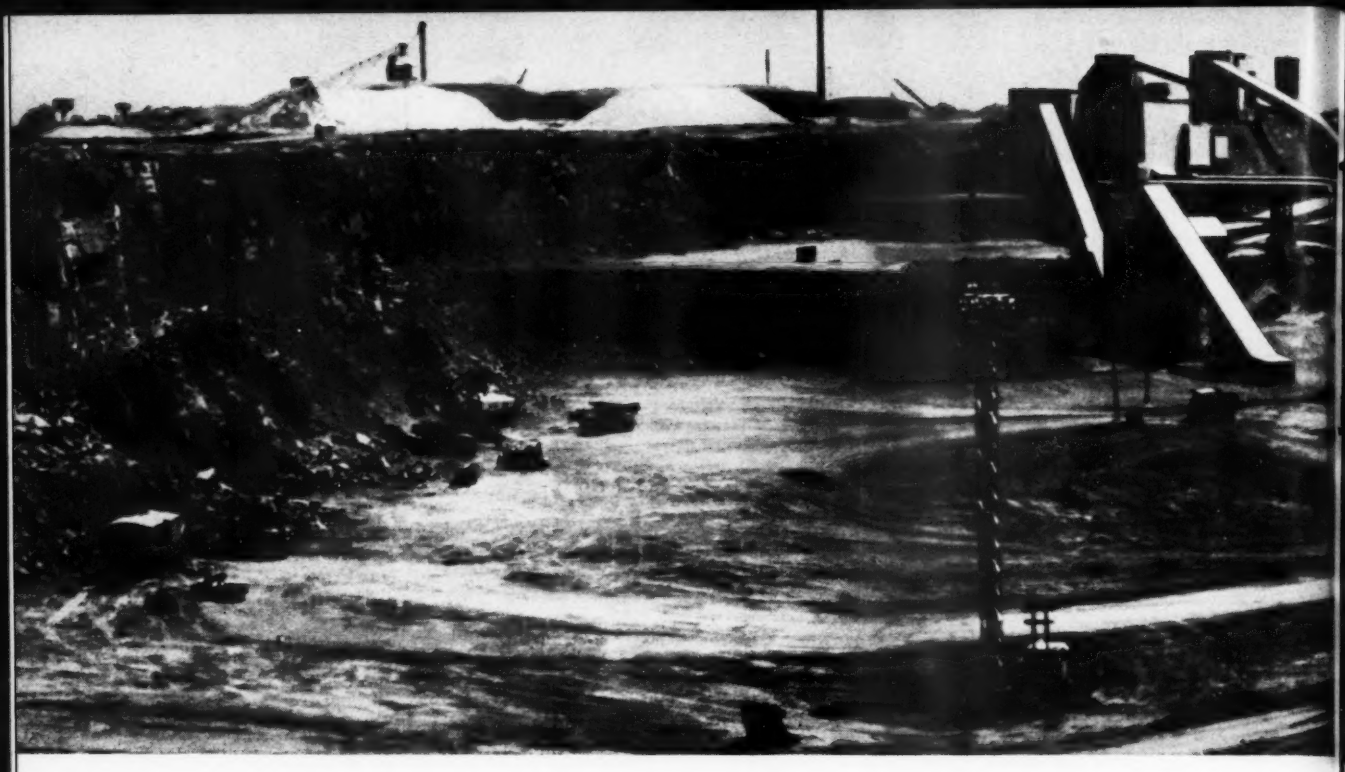


Get your personnel to and from the working face quicker . . . safer! Check the advantages of the Lee-Norse Mine Portal Bus.

Lee-Norse Company

Specialists in Coal Mining Equipment

CHARLEROI, PA.



Moving 16,000 to 20,000 tons of

One of the biggest and most efficient stone-crushing plants on this continent is owned by The Highway Paving Company Limited of Montreal, which recently increased its capacity from over 400 tons per hour to over 1600 tons per hour.

Almost all of this operation is automatic. However, quadrupling production involved moving rock from quarry face to crusher in sufficient quantity to assure Highway Paving's booming operations of a continuous supply of crushed stone.

Seven Macks were given the job. Working under six-yard electric shovels, they shuttle from shovel to crusher, each making 10 trips an hour; the seven trucks average over 16,000 tons per day. The shovels really have to move to keep up with the hustling Macks, which are on the go 10 hours a day.

Highway Paving knows that its production of crushed stone is dependent on equipment that must maintain "the pace that kills", day after week after month, without crippling breakdowns. Their Macks

Mack being loaded by one of the six-yard electric shovels. The Macks take a brutal beating from the seven-ton impact of broken limestone dropped with each shovel pass . . . but come right back for more.

rock per 10 hour day with 7 trucks

have proved that they are worthy of this dependence. In fact, no other make of dump vehicle is used in this quarry.

Macks have everything it takes for dependable, profitable quarry, mine or construction hauling. Your nearest Mack representative will be glad to give you the names of Mack users in your area who are racking up new production records, with minimum down time and top economy. Mack Trucks, Inc., Plainfield, New Jersey. In Canada: Mack Trucks of Canada, Ltd.

MACK
first name for
TRUCKS

5511

Dumping rock into Highway Paving's huge crusher which is so located that trucks can dump into it from both sides. Number of loads emptied into crusher are counted electronically, and tonnage crushed is determined by belt weighing equipment.

How to get better coal hauler engine performance—

use STANDARD DIESEL FUELS

STANDARD Diesel Fuels—now with STA-CLEAN*—deliver the *big* benefits that help you get (1) the power your coal hauler engines are rated to deliver, (2) the performance economy you must have, (3) the low maintenance costs that mean profitable operations.

STA-CLEAN is a STANDARD Diesel Fuel exclusive. This additive prevents fuel-injector sticking, insures clean burning of the fuel, prevents rusting of tanks, fuel lines, and injector parts.

Clean fuel. Standard exercises special care in handling diesel fuel to make sure it's delivered to you as clean as it was when it left the refinery. Contamination is eliminated. There's no foreign matter in the fuel to cause engine failure or maintenance problems.

Balanced distillation of STANDARD Diesel Fuels means good, as well as economical, performance; and with cleaner engine operation, you may be able to extend overhaul periods for your coal haulers.

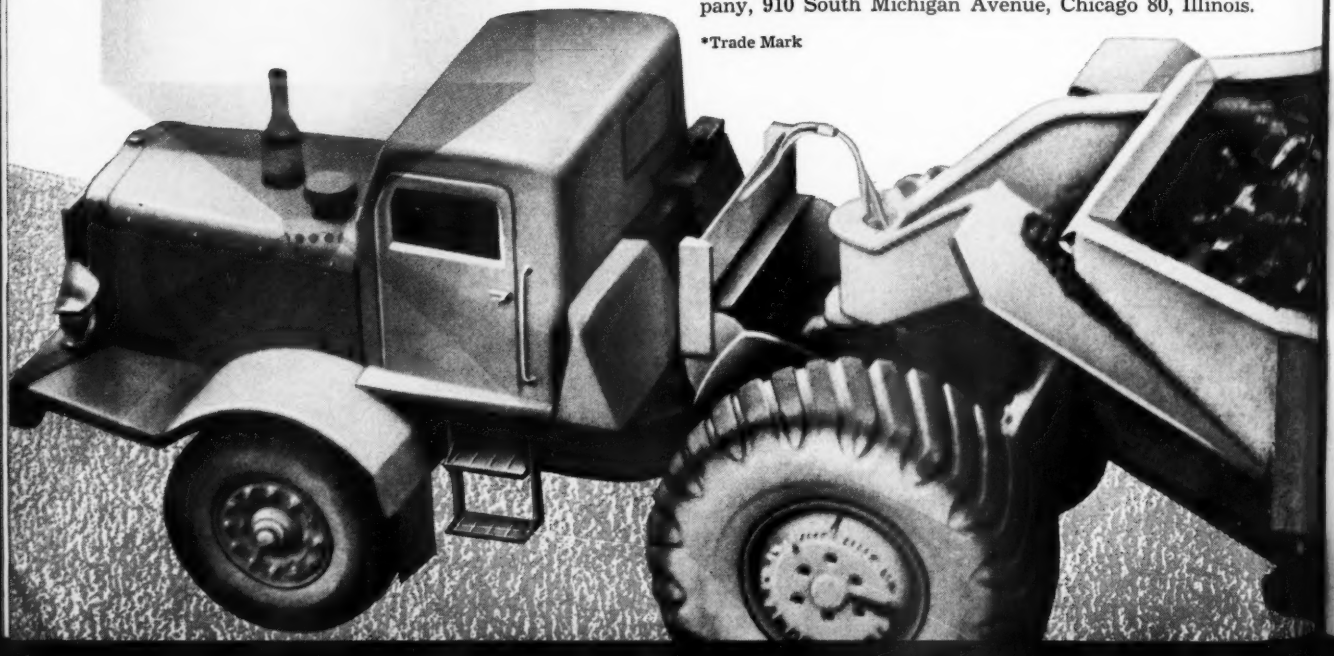
Low pour point. STANDARD Diesel Fuels delivered to operators in cold climates have a pour point of −20° F. or lower . . . plenty of margin here to insure uninterrupted operation at low temperatures.

Get the facts about STANDARD Diesel Fuels from your Standard Oil industrial lubrication specialist. There's one of these specialists near you in any of the 15 Midwest and Rocky Mountain states. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

*Trade Mark

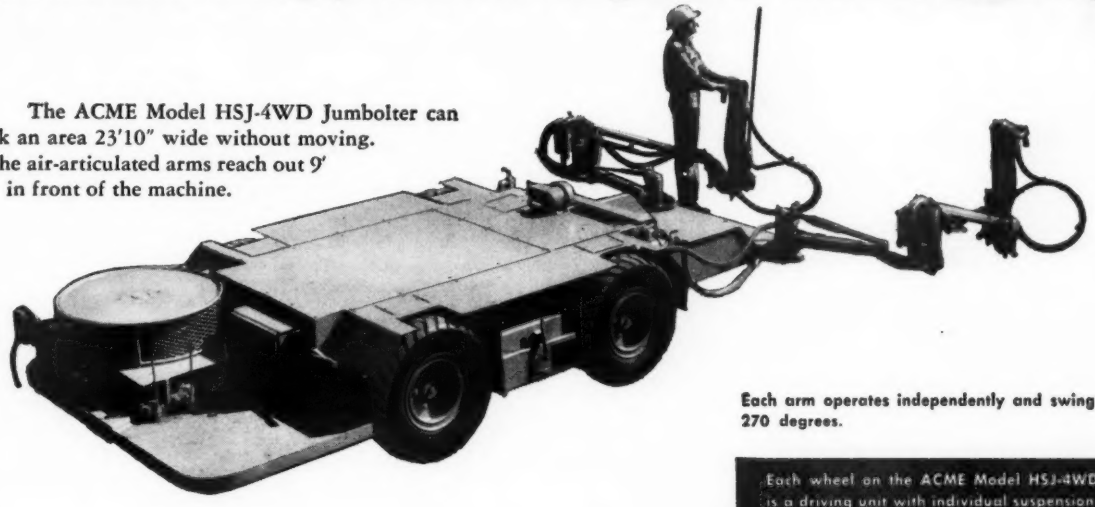
STANDARD OIL COMPANY
(Indiana)

STANDARD



ACME jumbolter now has 4 wheel drive

plus elevating platform for greater manuverability



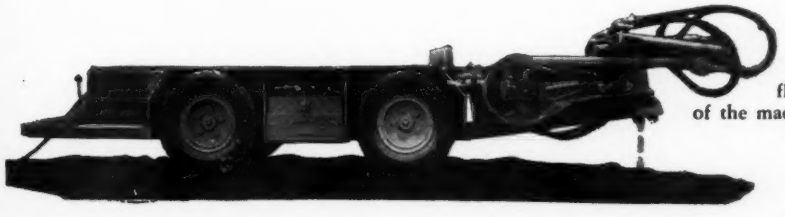
The ACME Model HSJ-4WD Jumbolter can work an area 23'10" wide without moving. The air-articulated arms reach out 9' in front of the machine.

Each arm operates independently and swings 270 degrees.

Each wheel on the ACME Model HSJ-4WD is a driving unit with individual suspension. Large gear reducers are rugged enough to withstand the roughest floor conditions.

The versatile ACME Model HSJ-4WD Jumbolter is now equipped with tractor-type 4 Wheel Drive permitting shorter turning radius. Left hand and right hand wheels are integrated units so that by reversing the wheels on one side while driving forward on the other side the Jumbolter can be made to turn in almost its own length.

Available with either one or two air-articulated arms, each individually controlled, the ACME Jumbolter permits bolting in a wide flexible pattern from 8′ to 10′ back of the working face.



The front platform of the Model HSJ-4WD can be elevated 8" to clear floor obstructions during forward movement of the machine. Hydraulic cylinders raise and lower the platform. A locking device holds platform for in-tram position. Complete details of Model HSJ-4WD are given in Bulletin 4WD.

ACME MACHINERY COMPANY

ACME MACHINERY COMPANY

WILLIAMSON, WEST VIRGINIA

WAREHOUSE AND SALES OFFICE
MORGANTOWN, W. VA.

REPRESENTATIVES IN PRINCIPAL MINING AREAS

Ohio Brass

FIRST IN MINE HAULAGE

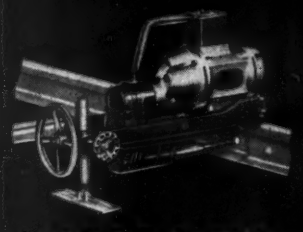
locomotive equipment, rail bonds, line materials, automatic couplers, safety, and control equipment.

If your problem concerns accessory equipment for mine haulage, you'll find a solution at Ohio Brass -- perhaps even among the O-B products and publications shown on these pages.

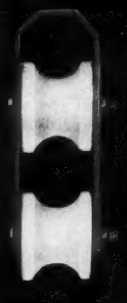
For over half a century, mine operators in this country and throughout the western hemisphere have come *first* to O-B with their coupler, collector, bond, line material, switch, and electrical equipment problems -- for every haulage need, in fact, from simple hangers to the most comprehensive blueprints for complete haulage systems.

To get our monthly "how-to-do-it" bulletins, or more information on any product, fill out and mail the coupon below.

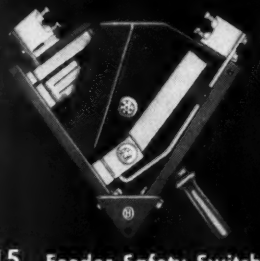
1. Cable Connectors



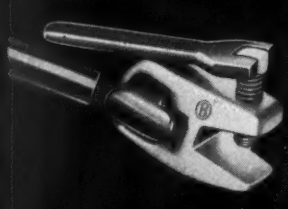
5. Rail Drills for Wedge Bonding



10. Porcelain Insulators



15. Feeder Safety Switches (Cover Removed)



19. Rail Clamps

OHIO BRASS COMPANY, MANSFIELD, OHIO

4805-M

Name .....

Company .....

Position .....

Address .....

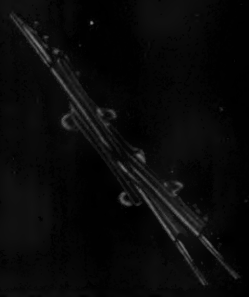
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

16 17 18 19 20 21 22 Other.....

☐ *A Storehouse of Ideas*—O-B Mining and Industrial Catalog No. 27 is loaded with suggestions for more efficient haulage. Check the box to get your copy.

☐ *A Library of Information*—O-B Haulage Ways brings 8,000 mining men "how-to-do-it" articles and new product information every month. Just check the box to add your name to the list.

☐ *Aluminum Feeder Cable*—Supplement No. 1 to the O-B No. 27 Catalog lists O-B fittings for aluminum cable and describes correct installation procedures. Check box for your copy.



2. Trolley Frogs, Crossovers

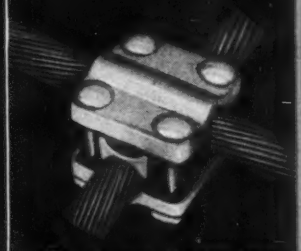
3. Expansion Bolts

4. Automatic Couplers

6. Trolley Wire Clamps

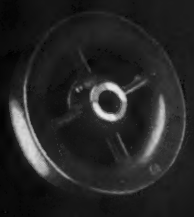
7. Hanger Adapters

8. Insulated Hangers



9. Branch Connectors

11. Trolley Wire Conditioning Equipment



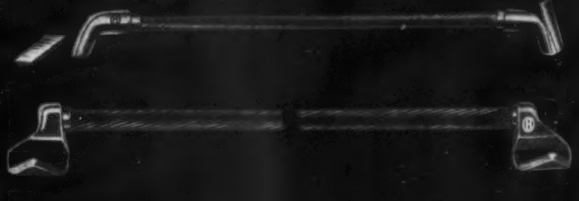
12. Wheel Collectors

13. Feeder and Trolley Splicers

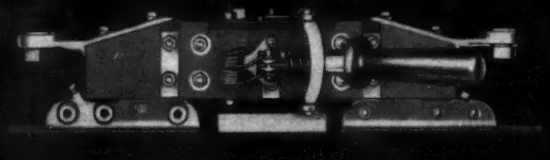
14. Quick Break Switche

16. Shoe Collectors

17. Fused Taps



18. Rail Bonds



20. Section Insulator Switches

21. Combination Feeder Trolley Clamps

22. Bond Welding Equipment

Rides with the bit through rock

...speeds big bore hole cuts...

GARDNER-DENVER

"MOLE-DRIL"*

TRADE-MARK

Here's added power for your rotary rig—hard-hitting, in-the-hole power. "Mole-Dril" speeds deep hole drilling in ore and overburden.

It's easy to use—the "Mole-Dril" screws directly onto the bottom of standard drill pipe . . . a tungsten-carbide "X" bit screws directly onto drill tappet. That's all the "make-ready" it takes to send the "Mole-Dril" through rock.

It's powerful—"Mole-Dril" delivers more foot-pounds of energy to the bit than any other drill of its size. Every pound of hammer energy is transferred directly to the bit.

It's rugged—the "Mole-Dril" has only three moving parts, nine major parts. This simple, rugged construction gives the "Mole-Dril" lasting deep hole drilling durability.

Two models available:

Model AM4 for drilling 4¾" diameter hole.
Model AM6 for drilling 6½" diameter hole.
Write for bulletin.

"Mole-Dril's" positive hole cleaning action

Air at full line pressure flows through drill's air blowing tube directly to bit . . . this direct air stream keeps cutting face clean regardless of drilling depth.

Drill exhaust air passes out up-cast air ports and gives cuttings an additional out-of-the-hole boost.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

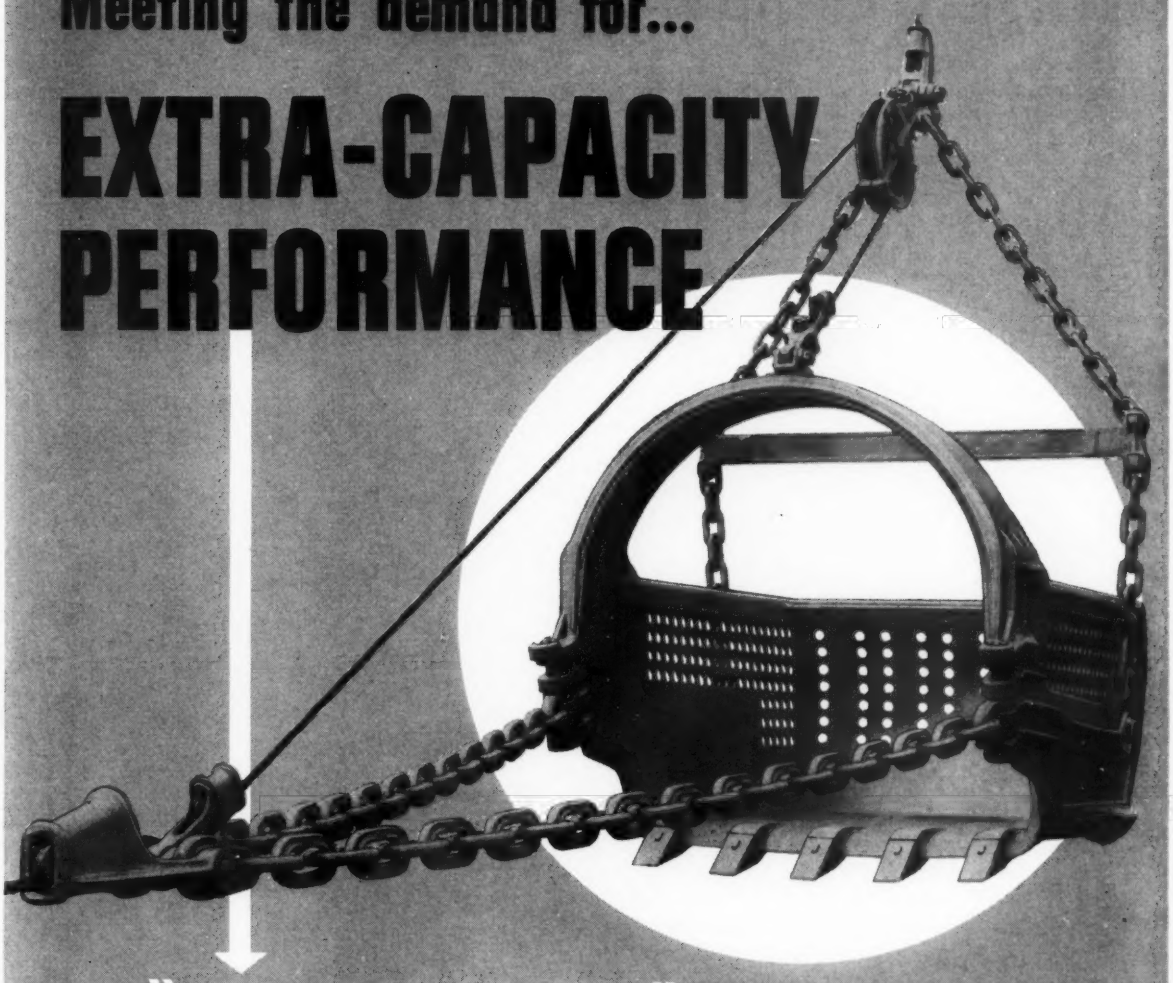
GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois
Export Division, 233 Broadway, New York 7, New York

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

Meeting the demand for...

EXTRA-CAPACITY PERFORMANCE



"MH" HENDRIX

Heavy Duty Mining Buckets

Keeping pace with the ever-changing conditions in today's more difficult stripping operations, The Hendrix "MH" is the answer to the industry's demand for a rugged, extra-capacity mining bucket.

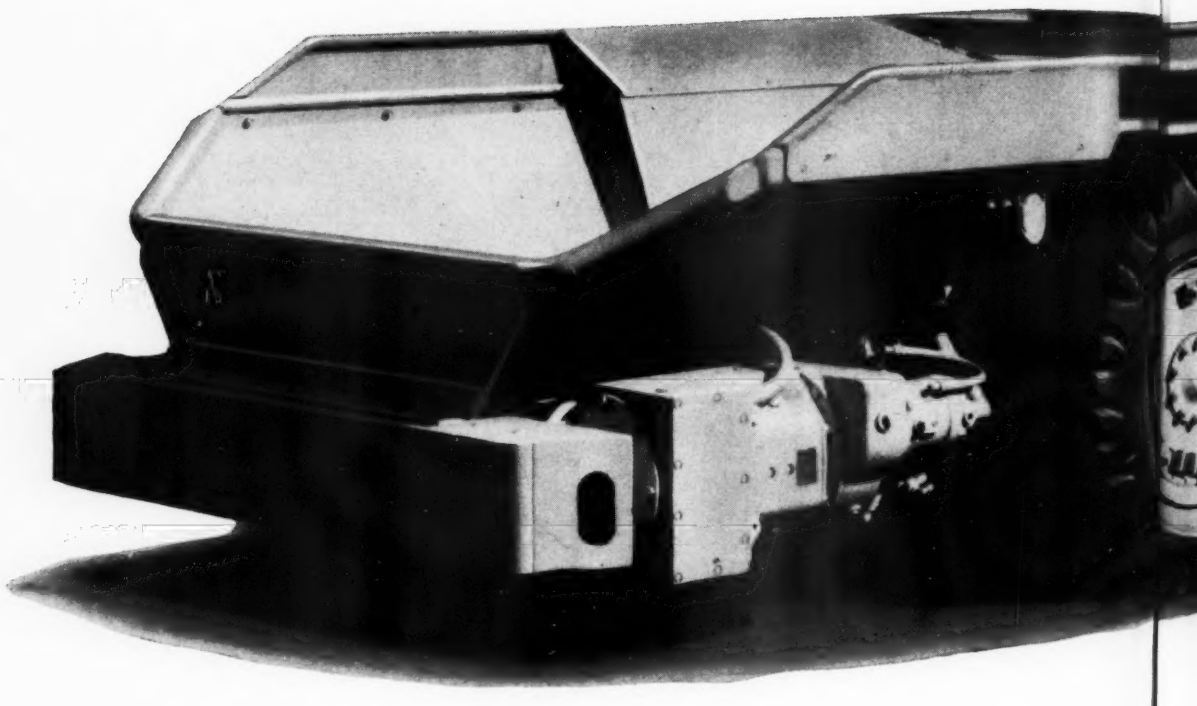
Increased bucket width, higher arch, tapered basket, arched lip and extra strength throughout provide unsurpassed digging, loading and dumping ... assuring greater production at a lower cost-per-ton.

4½ to 14 Cubic Yards With or Without Perforations

HENDRIX MANUFACTURING CO., Inc.
MANSFIELD, LOUISIANA

Hendrix DRAGLINE BUCKETS

Jerk-free acceleration...
Instant response



Jeffrey shuttle cars...

67 MT Shuttle Cars work efficiently on grades 20 to 26%

Class 67 Shuttle Cars are in heights from 44" to 60"

available in AC or DC power

Progression of power on a Jeffrey shuttle car is s-m-o-o-t-h. ***So smooth you can't feel it shift.*** There's no jerk as the motors are shifted from "low" to "high". Control is simple, too, since it's automatic.

Like all Jeffrey mining machinery, Jeffrey shuttle cars are available for either AC or DC power. With Jeffrey equipment you can make your mine all-AC.

Payloads can be matched to your mining height, ranging from 4.6 tons to 9.2 tons; 88" or 96" wide. Fast loading and unloading are easy for the operator as he has the aid of the variable speed, hydraulically driven discharge conveyor. Can be reversed instantly to clear jammed lumps.

Jeffrey shuttle cars are highly maneuverable: four-wheel drive with no-slip differential between wheels on the same axle... four-wheel steering... four-wheel disc type hydraulic brakes... full magnetic, progressive series-parallel acceleration with hand-selection series position.

THE JEFFREY MANUFACTURING COMPANY
958 North Fourth Street, Columbus 16, Ohio

CONVEYING • PROCESSING • MINING EQUIPMENT...
TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

JEFFREY

DU PONT ANNOUNCES...

Royalties slashed 50% on AKREMITE*

Now—save more money than ever before with this low-cost blasting agent

Designed and carefully compounded to give high energy, greater safety, easy loading, uniformly reliable results. Here's how to trim your overall costs to the bone.

Use the Akremite blasting method, designed for large-diameter holes in medium-hard material. You can make your own Akremite by a simple process (under sub-licensing arrangement with Du Pont or other licensed explosives manufacturers) or you can buy Akremite direct.

Either way, you save blasting dollars, because the proven reliability of Akremite makes it the most economical blasting agent you can use—*and now the royalties have been cut in half.* This also applies to the new improved formulation now available.

You can use Akremite for stripping, open-pit mining, or other large diameter shooting. Besides saving money, it offers you several other advantages:

High Energy. Excellent blasting efficiency, as proven by the experience of large bituminous-coal strip pit operators and others under a wide variety of conditions.

Increased Safety. Can't be detonated by blasting caps, friction, shock or even standard "Primacord." Relatively insensitive Nitramite® primers or properly sized dynamite or non-nitroglycerin primers are necessary to do the job.

Fast, Easy Loading. Akremite is packaged in moisture-resistant plastic bags which are flexible and conform to the shape of the borehole to give maximum loading density and performance. They are easy to handle, and easy to load.

There's no Nitroglycerin in Akremite, either, so you have no "powder" headaches.

Write us for complete details, or contact any of the companies listed at lower left. E. I. du Pont de Nemours & Co. (Inc.), Explosives Dept., Wilmington 98, Del.

Licensed exclusively to the Du Pont Company under the Maumee Collieries Co. Process Patent No. 2,703,528 and presently sublicensed to:

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ATLAS POWDER COMPANY
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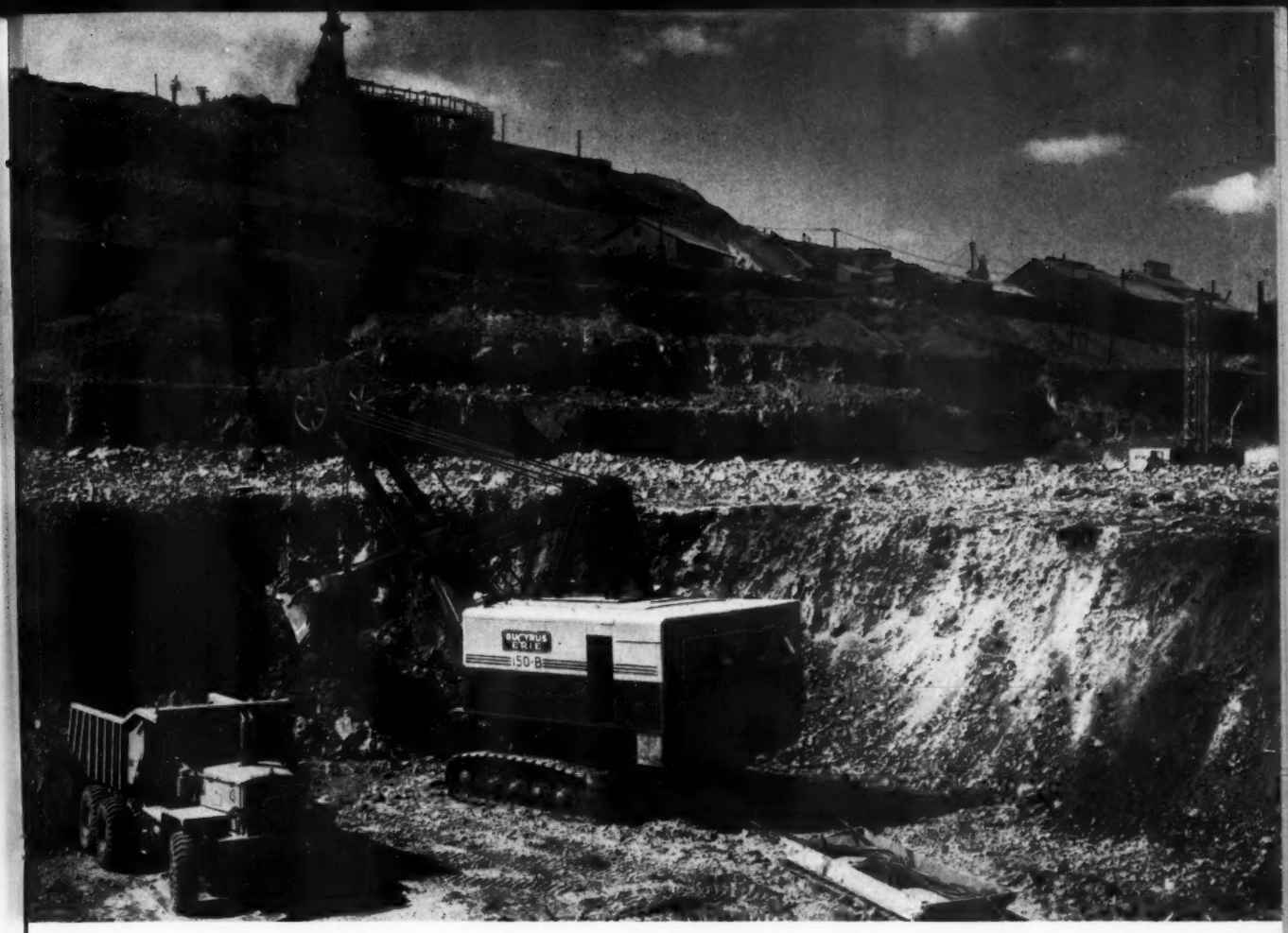
ILLINOIS POWDER MANUFACTURING COMPANY
INDEPENDENT EXPLOSIVES COMPANY
INDEPENDENT EXPLOSIVES COMPANY OF PENN.
KING POWDER COMPANY
PACIFIC POWDER COMPANY
TROJAN POWDER COMPANY

AKREMITE
BLASTING METHOD
licensed to

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*



This 150-B is one of several Bucyrus-Erie electric shovels working at a large open pit copper mine in Montana.

In Montana . . . and the World Over

Bucyrus-Erie Electric Shovels are a First Step to Profitable Production

Opening a new pit or working an old one, Bucyrus-Erie shovels can be depended upon to help hold mining costs in line. Here in a big Montana open-pit copper mine, they deliver big yardages economically day in and day out.

These machines are engineered specifically to meet today's high production demands. The exclusive front-end design, with two-section boom and tubular dipper stick, reduces weight and assures plenty of strength for tough digging. Because there is less deadweight, swing speeds are faster and there are more payloads every hour. Powerful main machinery is easily accessible for servicing. Exceptional smoothness and ease of operation result from Ward Leonard electric controls.

Find out more about how Bucyrus-Erie electric shovels can help you reach production goals economically. 141L57C

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6-cu. yd.
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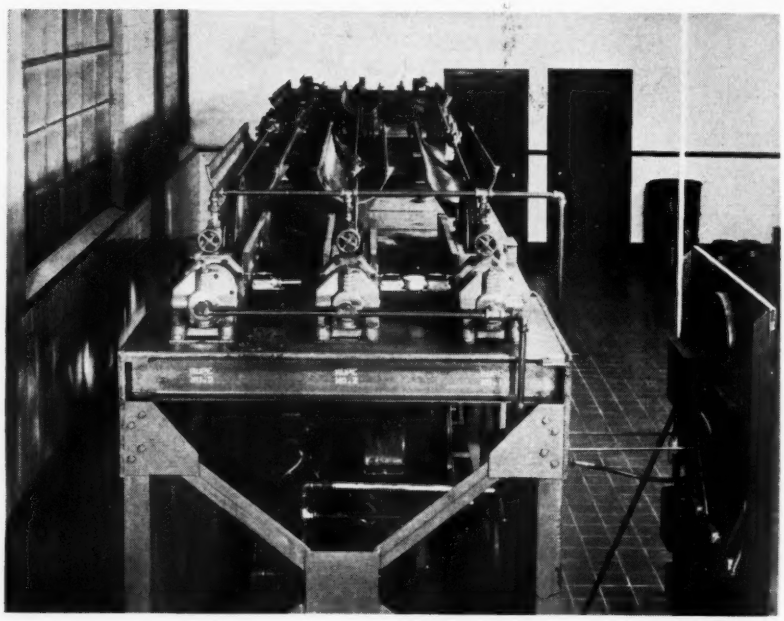
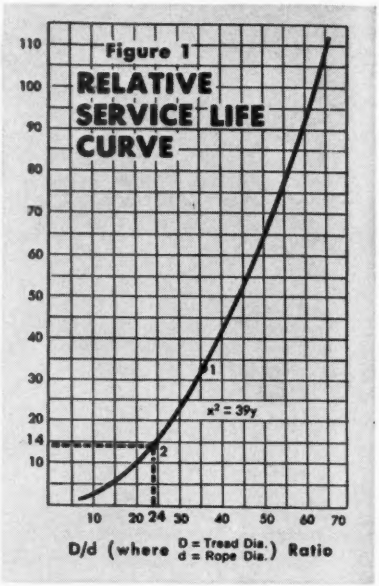
BUCYRUS-ERIE COMPANY

SOUTH MILWAUKEE, WISCONSIN

Tuffy® Wire Rope





How Union Wire Rope Fatigue Tester Scientifically Predetermines Rope Life

How much service life can you expect from a given wire rope construction? Until recently there was very little factual data to answer that question. Predicting how long a certain wire rope would last under a given set of operating conditions was largely a matter of guesswork, trial-and-error and generally inexact calculations.

Knowing that bending stresses are a major factor in wire rope life, Union Wire Rope engineers designed the Accelerated Fatigue Tester, shown above, to pin down the effects of bending. Now, from a long series of bending tests, scientific data has been accumulated and organized to take the place of former rule-of-thumb methods.

"Preview" of Service Life You Can Expect

The data established by this laboratory research is based on the effects of various sheave diameters on bending stresses of various constructions of wire rope.

From test data, bending life curves have been plotted by Union Wire Rope Engineers for each of the more widely used rope constructions. Analysis of each of these curves showed them to follow a pattern expressed by the curve shown in Fig. 1 at right, above.

Note on Fig. 1 the curve shows that as the ratio of tread diameter to rope diameter increases (see D/d figures at bottom of chart) the longer the relative service life as expressed by the figures at the left of the chart.

However, there are few pieces of equipment on which sheave and drum sizes can be large enough to afford D/d ratios above 50. From test data the general-purpose range of D/d ratios was determined. Those recommended are set up in Table 3.

Spotted on the curve, for example, is the D/d ratio of 24 at point 2 and D/d ratio of 36 at point 1—these being the range for general purposes taken from Table 3 for the 6x25 filler rope. Moving from these points to the left on the chart, the relative service life of this rope ranges from 14 to 34 units of any service measure used, such as yards, tons, days, etc.

Table 2

BENDING-LIFE FACTORS

When Using Curve of 6x25 FW

CONSTRUCTION	FACTOR
6x7	0.57
18x7	0.67
6x17 Seale	0.73
6x19 Seale	0.80
6x21 Filler Wire	0.92
6x25 Filler Wire	1.00
6x31	1.00
8x19 Seale	1.14
6x37	1.33
8x19 Warrington	1.33
Tiller Rope	2.00

Table 3

SHEAVE DIAMETER FACTORS

ROPE CONSTRUCTION	GENERAL PURPOSE RANGE D/d Ratios	
		Where D = Tread Dia. d = Rope Dia.
6x7	63	42
18x7	54	36
6x17 Seale	49	33
6x19 Seale	45	30
6x21 Filler Wire	39	26
6x25 Filler Wire	36	24
6x31	33	22
8x19 Seale	31	21
6x37	27	18
8x19 Warrington	27	18
Tiller Rope	18	12

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Tips

Now to determine the relative service life of say a 6x37. Its bending life factor (see Table 2) is 1.33 as compared to 1.00 for the 6x25 filler wire. Multiply the service life readings of 14 and 25 for the 6x25 filler wire by 1.33, and we find the service life range of the 6x37 falls at 18 and 27 units of service. Relative service life of other ropes are determined in the same way by using the bending factor indicated for each as the multiplier.

Of course bending is not the only wear factor in wire rope operation. Hence the general rule—that more flexible ropes should be used as bending stress increases with decrease in diameter of sheave or drum—has to be modified in field use. Other principal operating conditions—in addition to bending stresses—that affect wire rope service life are loading conditions, portability, corrosion, abrasion, rope speeds, materials handled, and equipment design. You can get further information on all wear factors from your Union Wire Rope distributor or the Union Wire Rope Corporation engineering staff.

Ordering is ABC-Simple!

No complicated codes or long list of specifications. Just say "Tuffy", give type (Scraper Rope, Dozer Rope, etc.), length wanted and size. Just that easy!

Good Man to Know: Your Nearby Union Wire Rope Distributor

Whether your wire rope need is a scheduled replacement or a red-hot emergency, your Union Wire Rope distributor is ready with "right-now" service. He keeps varied stocks of Union standard constructions and the Tuffy Special Purpose Ropes. And he's backed by quick service from his nearby Union Wire Rope depot.

If it isn't rope you need, but advice on a wire rope problem, he's just as ready to help. If you don't know your Union Wire Rope distributor already, look under "Wire Ropes" or "Slings" in your telephone directory yellow pages.

Excessive strength can make a rope "muscle-bound"... Wire Rope must be

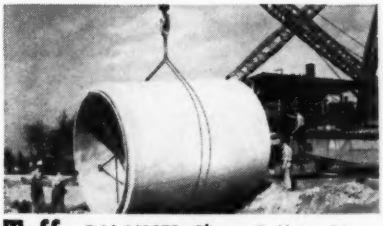
BALANCED

Buying wire rope on the basis of strength alone leaves other important properties out of consideration. Wire rope, like athletes, can be "muscle-bound" with too much strength.

Strength is not always the answer to the question of the proper rope to use. Strength does not increase flexibility, resistance to crushing, abrasive or fatigue-resistant qualities. Strength does not compensate for the core crushing which accompanies excessive loading.

The Tuffy ropes are engineered for each end-use of the different types of rope. The combination of strength, toughness and flexibility is different for each application. The way to be sure your rope is BALANCED for its job is to use Union Wire Rope. Get in touch with your Union distributor.

Tuffy Special Purpose Ropes: tailored and BALANCED for special uses

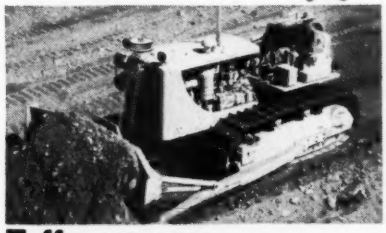


Tuffy BALANCED Slings & Hoist Lines

Top-performing team in every type of materials handling. Tuffy Slings are made of a patented, machine-braided fabric; stays extra flexible, can't be seriously hurt by knotting or kinking. Tuffy Hoist Line is a special construction of super flexibility and toughness.

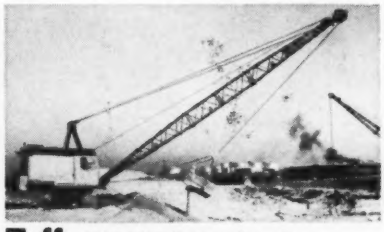
Tuffy BALANCED Scraper Rope

It's flexible enough to withstand sharp bends, yet stiff enough to resist looping and kinking when slack. Moves more yardage per foot because it's specially built and balanced to take the beating of drum-crushing abuse.



Tuffy BALANCED Dozer Rope

Built to give you longer service with less downtime. 150' reels of 1/2" or 9/16" mounted on your dozers allow you to cut off worn sections without wasting good rope. Put Tuffy Dozer Rope on the job and watch costs go down!



Tuffy BALANCED Dragline Rope

Made to give you maximum abrasive resistance with super flexibility. Rides smoothly on grooves; hugs the drum when casting for full load. Consistently dependable in handling any material — wet or dry dirt, sand, gravel, rock, cement or minerals.

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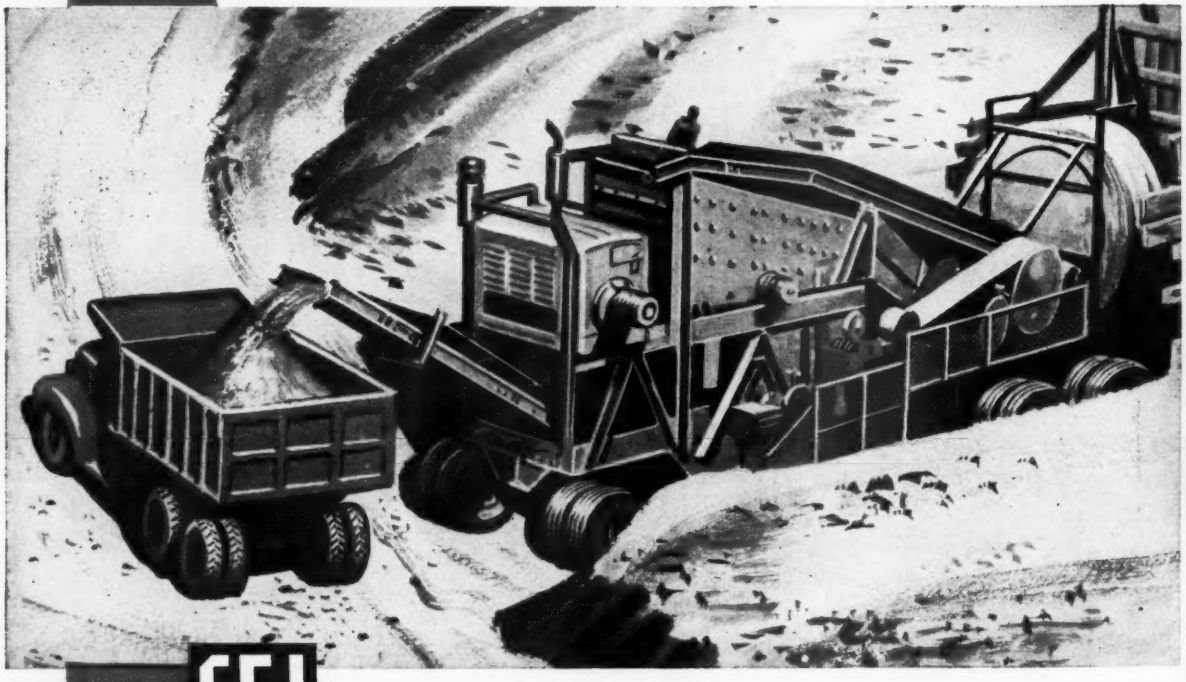

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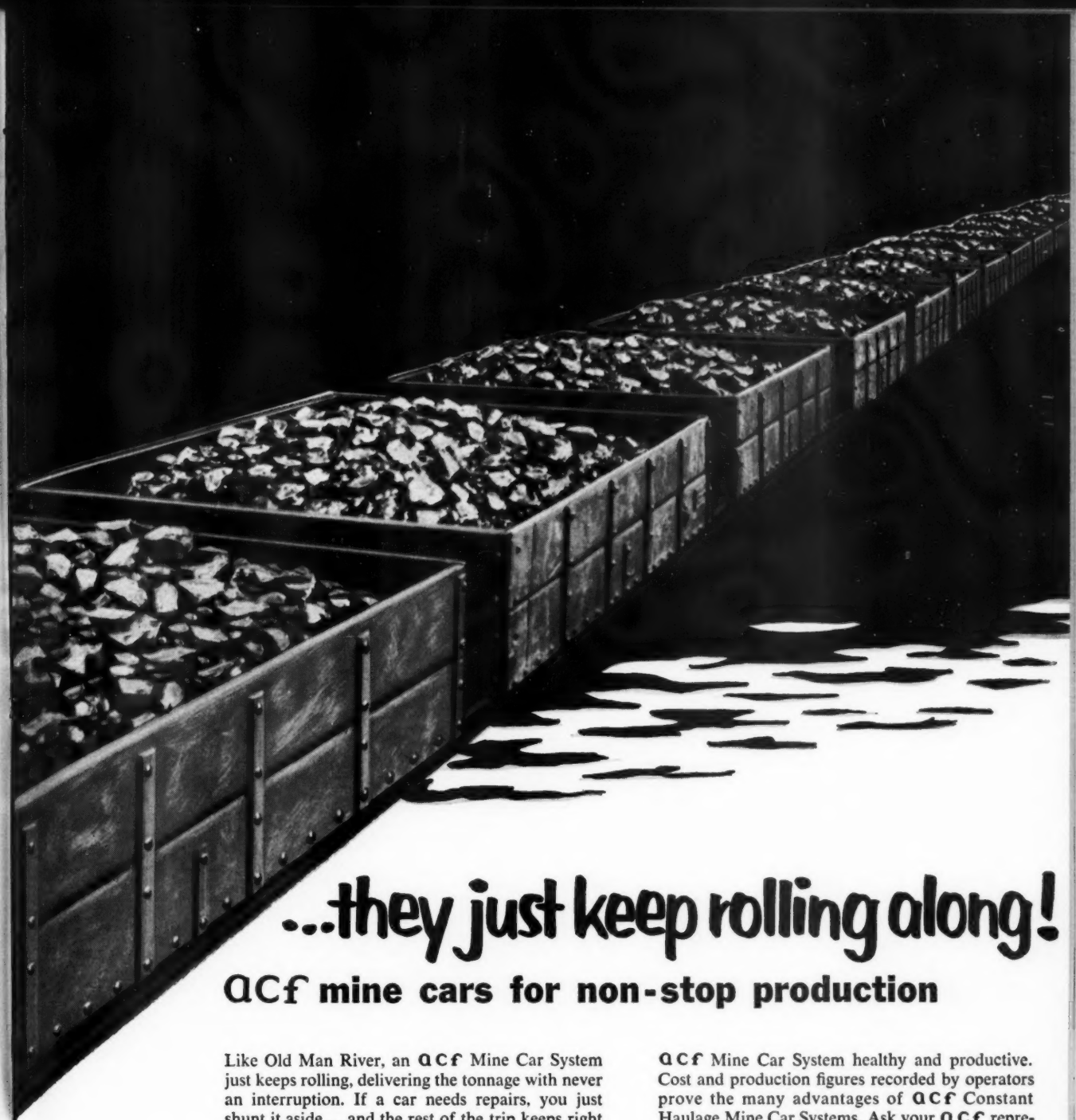

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Profits start in the Pit!

There are over 1300 "Eucs" on Minnesota's Iron Ranges—more than all other makes of off-the-highway trucks combined! Rear-Dumps, with payload capacities to 50 tons, work the year around hauling ore and heavy overburden. On this tough "proving ground" Euclid performance has consistently paid off in more production and lower hauling costs.

Their dependable performance and high job availability, combined with big payload capacity and fast travel speeds, have made "Eucs" the preferred hauling equipment for open pit mines and quarries. Because they're built for tough off-the-highway service, Euclids make more profits for owners by cutting the cost of hauling stone, ore, overburden and waste.

Your Euclid dealer can show you the way to lower hauling costs . . . have him provide a hauling production and cost estimate for your operation . . . there's no obligation, of course, so get in touch with him soon.

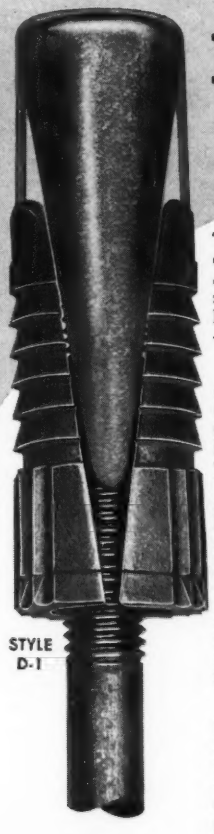
EUCLID DIVISION, GENERAL MOTORS CORPORATION, Cleveland 17, Ohio

Working at a large open-pit copper mine in Arizona, a fleet of 34-ton "Eucs" maintain high production at low operating and maintenance cost. Their dependable performance and high job availability make "Eucs" an important part of the profit picture on this and many other mine and quarry operations throughout the world.

Euclid Equipment

FOR MOVING EARTH, ROCK, COAL AND ORE

Get DOUBLE EXPANSION for DEPENDABLE roof support with PATTIN roof bolts and expansion shells



STYLE D-1

The unique double expansion feature of all Pattin expansion shells insures *dependable* roof support, in hard or soft roof conditions. Their double holding power guards against failure — even under a 20 ton pull!

Pattin features include a parallel contact with the hole, and no definite drilling depth is required, as the shell can be securely anchored at any place in the hole. They anchor solidly and will not turn while being tightened. Wedge and shell are assembled in a manner to prevent loss of parts in handling, and the bolt and shell assembly are furnished as a complete unit. Plates are bundled separately. No special nuts or ears are required on the bolts. These features make a safer roof — and a safer roof means fewer accidents, increased production, more clearance for equipment operation and better ventilation.

Pattin specializes in roof bolting—it's our business, not just a sideline! Your business is important to us, and our service engineers are always available for consultation on your roof problems—ready to give you service when you need it! WRITE OR PHONE US TODAY for complete details.

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The PATTIN split-type BOLT

The split-type bolt is one of the first slotted bolts, and continues to be a favorite wherever split-type bolts are used. Many mines still prefer this type. The bolt is a full 1-inch in diameter, with cut threads and furnished with hex or square nuts and various size plates and wedges.

IN WESTERN STATES

Pattin expansion shells are available and serviced exclusively by Colorado Fuel and Iron Corporation, Denver, Colorado. Western mining companies should contact them direct for information and consultation.

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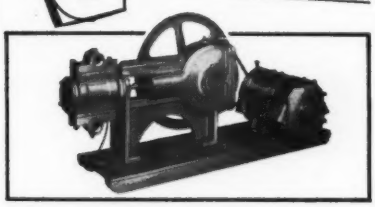
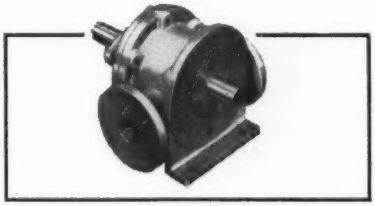


Gathering Type PLUNGER PUMP— dependable, light, compact. Has many uses. Pipe connections are brought into proper position by reversing suction and discharge chambers. 42" long, 17" wide, 22" high, weight (less motor) 260 pounds.



High Pressure SPRAY or FIRE PUMP— round stainless steel rollers prevent clogging and jamming by coal and dirt particles. Uses less power—friction is reduced. Produced in various capacities—10 GPM at 100-125 PSI for spraying. 50 GPM at 50 PSI for fire needs.

CENTRIFUGAL PUMPS highly rated for complete reliability and service. All sizes to 8" discharge and 1500 GPM. In acid-resisting bronze or stainless steel.

PUMP REPLACEMENT PARTS for practically all types and makes of centrifugal and plunger pumps.

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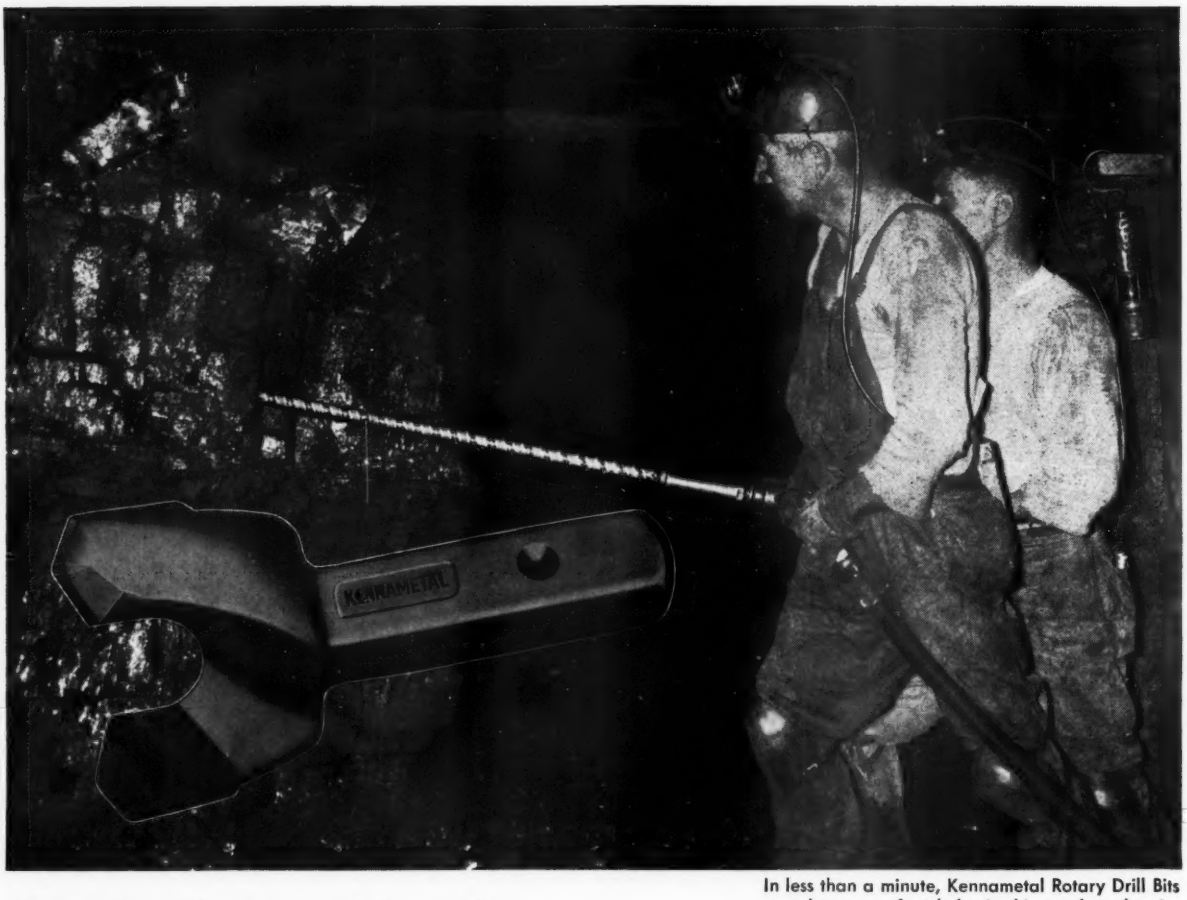

In less than a minute, Kennametal Rotary Drill Bits complete seven-foot holes in this tough anthracite seam near Wilkes-Barre, Pennsylvania.

Through rock, bone, slate, sulfur . . .

KENNAMETAL* Rotary Drill Bits are the answer to tough anthracite drilling problems

Since the mine's beginning in August, 1956, drilling conditions have been exceptionally tough at Slope 131 of Hanover Coal Company's Sugar Notch Colliery. This virgin basin of the Number Three Seam ranges from 36 to 72 inches, with lenses of bone, slate and pyrite. In such conditions, drilling never gets "easy," but Kennametal RD 1⅝ and DL 1¾ Bits have provided the best answers yet.

As soon as they begin to get dull, signalled by the additional push required on the drill, bits are removed and resharpened. Regrinding time is very short, drilling is faster, easier, and carbide loss is kept to a minimum. Morgan Bird, General Manager, and Superintendent Robert Russavage report that bits average 40 regrinds, for a productive life of 4000 to 4500 feet. Drillers stress the very evident lessening of dust and noise when using the Kennametal Rotary Bits.

Near Nanticoke, Pennsylvania, in this same anthracite area, Kingston Excavating Company opened a new slope mine in December, 1956. Ranging from 7 to 12 feet, the Number Five Vein is on a pitch up to 60°, and contains partings of bone and rock, with streaks of sulfur. General Manager Herb Traher describes conditions as the "toughest drilling I have encountered in the Northern Anthracite Field." Kennametal Rotary Bits have again provided the best answer. Using RD 1⅝ Bits and Kennametal A13-8 Augers, a face can be drilled in less than an hour, using only one bit. Bits average 35 to 40 regrinds, or 2800 to 3500 feet.

Let your Kennametal Representative help you select and actually test Kennametal Bits in *your* mine. You'll find his name listed in the Classified Section of your Telephone Directory under "Mining," or write KENNAMETAL INC., Mining Tool Division, Bedford, Pa.

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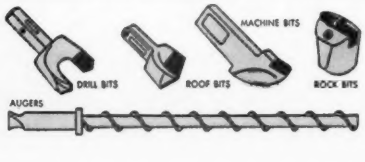

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EDITORIALS

ROBERT W. VAN EVERA, Editor

MARCH, 1958

TAKE HEED OF THE WARNING

ANALYSTS, commentators and forecasters, far better qualified than your editors, have made many observations concerning the current slow-down in business activity and the decline in the stock market since last July. Is the present period one of readjustment, recession or depression? Before one can answer that, he must know the meanings of the terms. It has been said that, "A readjustment is when a man down the street is laid off; a recession is when your brother-in-law loses his job, and a depression is when you get fired." No two people read the signs in exactly the same way.

High government officials have expressed the opinion that the present tapering off is not cause for real alarm. Indeed men in highly responsible positions could hardly justify a stand which might spread alarm, because alarm is an early symptom of panic—and panic solves nothing. Most of the nation's best known economists and business leaders, however, subscribe strongly to the view that the country is not "going to pot."

All segments of the mineral industries have problems, and some of these today—as where excessive imports have forced prices down to uneconomic levels—are serious. So, according to the above definition of a depression, mining men in the more distressed branches of the industry have some reason to see only the dark side of the current picture. However, the mining industry is resolutely facing up to the situation and putting forth its best efforts to improve it.

For the country as a whole this is a time for teamwork as never before, and all of the parties in our economy—capital, labor, management and Government—must unite to put out the fires before a major blaze develops. What can be done to prevent deterioration of of our economic system?

Above all, if psychological factors are as important to prosperity as we believe they are, measures must be taken to preserve opportunity and incentive for both capital and labor. Labor must have freedom from domination by a union organization just as it has freedom from oppression by an employer or the Government. And the investor should be allowed to put his resources to work in a sane fiscal and monetary environment, without discouraging, confiscatory taxation. Both should be afforded reasonable protection against ruinous foreign competition. For the general good, methods must be found to curb the spiraling inflation of wages and prices which automatically increases taxes, and destroys the traditional base of all monetary values.

Whatever the extent of the current economic slowdown, its impact can be lessened by moving *now* in the direction of sound policies that will preserve our industries, maintain incentives and provide fair treatment to all citizens.

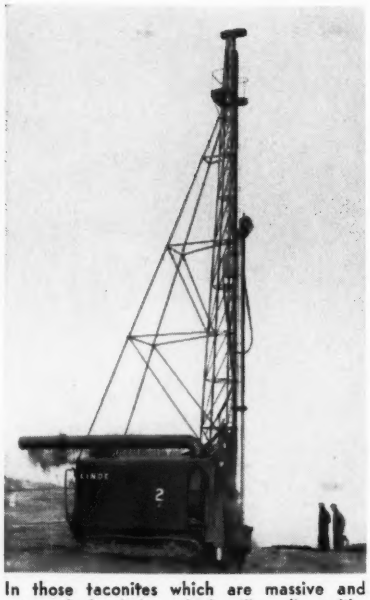
ENRICH, ENTERTAIN AND EDUCATE

TAKE a minute to ask yourself, "When was the last time I read a book?" Do you have to answer "Months ago," or simply, "I can't remember?" If so, you are no exception; a Gallup poll of 1955, surprisingly, showed that 61 percent of the adults in America had not read any book except possibly the Bible during the previous year. Another survey showed that half the nation's adults live within a mile of a public library, but only one-fifth of them go inside.

The life span has lengthened and leisure time has increased—sometimes by choice, other times by economic necessity. Obviously, many American people are missing a bet in not using more of this time for reading—periodicals and newspapers as well as books. True, many things compete for our leisure time, but the habit of reading is one that should be encouraged.

In a representative government, the information (or misinformation) in the minds of citizens is in reality the motive force behind governmental action. Our Government trusts its citizens to search out the truth, and that requires reading.

Consider too that reading is not only a source of enrichment to the individual, but an entertaining activity that can be practiced universally. It is especially satisfying in life's later years when other activities lose their interest or become impractical. But, one should not wait until then; the habit of reading worthwhile material is one that should be continuously practiced.



In those taconites which are massive and extremely hard, but which will spall readily, no drill has been found that can compete satisfactorily with the jet piercer drill. (Note the two men in the picture above for an idea of the size of the jet drill)

Drilling Taconites

Churn . . .

Rotary . . .

Percussion . . .

Jet Piercer . . .

Wide range of structure prescribes several types of drills

By IRVIN H. RUBOW

Superintendent
Pilotac Mine, Oliver Iron Mining Division
U. S. Steel Corp.

THE Pilotac mine is located on the Mesabi Range in northeastern Minnesota approximately two miles north of the village of Mt. Iron. In this area the Oliver Iron Mining Division of the U. S. Steel Corp. is conducting experimental work in an effort to determine the potential of taconite as a new source of iron ore.

The name Pilotac is a combination of two words—Pilot, meaning to steer or guide; and taconite, the name given to those rocks which comprise the iron formations of the Mesabi Range. These contain quartz, silicates, and several iron minerals. The term has also been used, however, when referring to similar low grade iron bearing rocks that occur elsewhere.

This article deals only with the tough, massive taconites of the central and eastern parts of the Mesabi Range. These rocks are sufficiently hard to cut glass.

The objective at the Pilotac mine is to provide sized ore for the crusher at a minimum cost. At the same time it provides a splendid opportunity to experiment and test all types of mining equipment that may play an important part in the economies of mining taconite. Since it will require about three tons of taconite to make one ton of concentrates, the savings made in mining will be threefold in the end product, not to mention that the tonnages involved will be tremendous.

Drilling 25 Percent of Mining Costs

Because drilling represents over 25 percent of the total cost of mining taconite, much of our study has been given to this particular phase of the operation. Since 1952, drill studies have been made of the churn drill, the Quarrymaster, the jet piercer drill, and the rotary drill in an attempt to determine their potential in the drilling of taconite. Explosive load factors of 1.25 lb of explosive per yd of broken material are the average rather than the exception. Rock density can best be expressed by saying that one yard of taconite weighs 2.4 tons, or 1 cu ft weighs approximately 200 lb.

With burdens and spacing of 22 by 24 feet respectively, it follows that we are speaking of large diameter blast holes of 9 in. or larger in order to accommodate the normal explosive load. In addition, to obtain satisfactory fragmentation, it is imperative that each blast hole carry its proportionate share of the total load with spacings distributed evenly throughout the blast. The location of holes, depth of holes, and collar elevations are accurately set by engineers in the field and duly recorded on drill maps. Detailed drill performance records are kept.

Churn Drill Used as Performance Yardstick

In October 1952, the first churn drill was started at Pilotac with discouraging results. 10 to 14 ft with three ft per bit sharpening was a usual shift. Mainly due to a systematic study, Pilotac now averages over 30 ft per shift with over 10 ft per bit sharpening. The above performance makes churn drilling competitive with other methods of drilling in taconite. Due to the data and experience gained, the churn drill is now used as a yardstick or a means of measuring the performance of any drill brought into Pilotac.

Two important items that improved performance vastly were the change in bit design and the determination of the proper length of stroke.

Churn drill bits and bit design: The original poor performance of drill bits

Irvin H. Rubow is aware of management's problems in overcoming natural obstacles to provide an economical mining operation. His work with Oliver Iron Mining Division began shortly after graduating from the University of Wisconsin in 1937 with a degree in mining engineering. Rubow became a pit foreman in the division's Hibbing-Chisholm district in 1940, assistant mine superintendent in the Canisteo district in 1942 and mine superintendent in that district two years later. He was made superintendent of Mountain Iron mines on the eastern Mesabi in 1950 and is now superintendent of the Pilotac mine which has been developed in the same vicinity.

made it obvious that a change in drill bit design was necessary. Our standard bit for drilling had a 15° angle of clearance, which did not leave enough metal to support the cutting edge of the bit. A change in the clearance angle from 15° to approximately 5°, with a corresponding increase of approximately 75 percent in the supporting metal on the cutting edge of the bit, has resulted in an increase of approximately 300 percent in footage per bit sharpening.

Length of stroke: To determine which length of stroke would be most efficient, three churn drills were used. For several months these churn drills operated in parallel rows 18 ft apart with strokes of 31 in., 40 in., and 46 in. The result of this experiment was as follows:

Stroke	Penetration Rate Per Hr	Ft Per Bit
31 inch	4.59	7.8
40 inch	4.98	11.5
46 inch	4.69	10.6

Needless to say, the 40-in. stroke is now used.

For the benefit of those who may be interested in churn drilling, a paper entitled "Churn Drilling in Taconite at Pilotac Mine" by Peter DelGreco, general drill and blast foreman, was given at the Drilling Symposium in October 1956 at the University of Minnesota.

Rotary Drills Successful in Some Ground

The first production drilling with the rotary blasthole drill started in September 1956. For testing purposes, areas considered to be relatively soft were drilled by the rotary drill.

In rotary drilling at Pilotac, a 9-in. tri-cone rock bit with tungsten carbide inserts is used. The bit has three rotating cones with their apex pointed to a common center. A rolling chipping-crushing action is achieved as the drill stem is rotated and downward pressure is applied on the drill stem. Downward pressure and rotational speed can be varied to suit the material drilled. At Pilotac, downward pressures on the bit vary from 6400 to approximately 6900 lb per in. of bit diameter. Rotational speeds vary from 32 to 35 rotations per min.

The rotary drill makes a smooth bore hole in taconite. Compressed air blowing through the holes in the bit disperses heat from the bit and, in addition, blows the cuttings out the collar of the hole; the finer particles are concentrated in a dust collector. The drill cuttings are used for analytical (sampling) and stemming purposes.

Penetrating speeds and bit life are directly related to structure, composition, and physical characteristics of the material drilled.

The drill stem assembly is centrally located on the drill rig, therefore it cannot drill closer than 10 ft to the crest of an open face or holes must be drilled approximately 12 ft from the toe of an open face. As crestline and back break holes represent approximately 30 percent of the drilling pattern at Pilotac mine, another type drill is required in conjunction with the rotary to complete a drill pattern. The churn drill has, to date, been drilling the holes in the drill pattern not accessible with the rotary drill. From the performance of the churn drill, it is possible to determine the type of taconite the rotary is drilling and, in turn, measure the performance of the rotary.

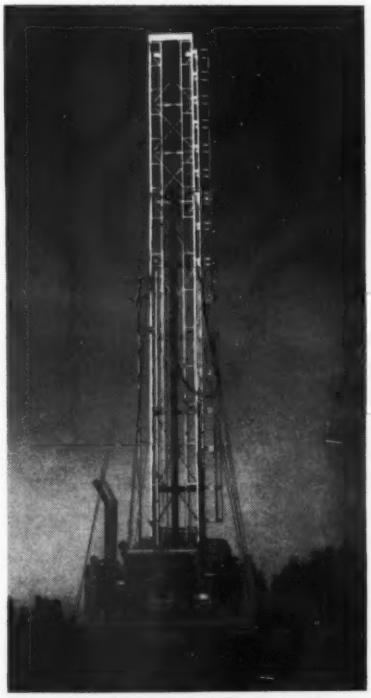
The best performance with the bit is experienced approximately after the first 200 ft of drilling. This is due to wearing away the matrix of the cones which in turn exposes better than 50 percent of tungsten carbide compacts or inserts. At this point larger cuttings are produced with a noticeable increase in the rate of penetration. The above continues through the life of the bit. Our experience has been that the heel or largest row breaks down first, and then the second largest row accompanied by breakage on the point of the cone. No loss of gauge is experienced and bits are run to destruction. Reaching the point of destruction in not a gradual process. The point of fatigue is reached suddenly. For all practical purposes, bearing and compact failure seem to develop simultaneously with the bearings having a slight advantage. It is interesting to note that rates of penetration have varied from 10 to 30 ft per hr, and bit life has varied from 250 to 850 ft.

The conclusions drawn in the drilling of taconite with rotary drills are as follows:

1. **Bit life is an important contributing factor to the cost of operating the rotary drill. The structure most conducive to good bit performance is a formation that is homogeneous and is readily chipped by applying pressure with the rotating action of the bit. Heterogenous material may provide good rates of penetration, but bit life is reduced considerably.**
2. **The speed of penetration of the rotary drill depends on the hardness and chipping-grinding resistance of the material drilled.**
3. **The rotary method of drilling eliminates the problem of water supply.**
4. **Drill cuttings which make good stemming material collect at the collar of the holes and are readily available for that purpose.**
5. **Drill bit sharpening facilities are not necessary since rotary bits are run to destruction.**
6. **The 9-in. bit will accommodate a maximum 8-in. diam. explosive cartridge.**
7. **Loose backbreak is exceedingly hard on bit life.**
8. **The smooth bore hole makes the loading of explosives easier.**
9. **Wet conditions affect drill progress.**
10. **With some improvement in bit and drill performance it may be economically feasible to drill the relatively softer taconites. An improvement of approximately 30 percent is needed. Softer materials are being drilled very economically with the rotary drill. Indeed, in the softer rock formations, penetrations of one ft per min. and 2000 to 3000 ft bit life are common.**

Jet Piercer Drill Effective in Hard Taconites

Jet piercing is a process for making blast holes in hard dense rock using a high velocity, high temperature



At present, the rotary drill's particular application is in drilling material softer than taconite. It has several advantages that make its use desirable, however, and with some improvement in bit and drill performance it may be economically feasible to drill the relatively softer taconites

flame which causes the rock to spall due to thermally induced stresses. The process fluids used are fuel oil, gaseous oxygen and water with consumption fixed on an hourly piercing or burning time basis. A specially designed rocket-type burner is the key to the process, and flame temperatures of approximately 4300°F are obtained. The jet pierce hole looks like a series of hour glasses, one on top of the other. One initial pass with the blowpipe produces a hole with an average diameter of approximately eight in. A succeeding pass in the bottom four to six feet, chambers the bottom to an average diameter of 10½ in. The significant features of the jet pierce drill are: the bit is always sharp, hole sizes are flexible, and shaped holes are possible. In those taconites which are massive, extremely hard, and spall readily, no drill has been found that can compete satisfactorily with the jet pierce drill. Rates of penetration of 35 ft per hr are common in this type of taconite. It is in these areas that, at times, over 200 ft of drilling is experienced in an eight-hour shift. Process fluids make up the major portion of the cost, with the cost of oxygen about 50 percent of the total. However, with oxygen being sold on a sliding scale (high volume—lower unit cost) it is conceivable in a large operation that the cost of oxygen could be reduced by 65 percent. The jet drill does very well in drilling the following:

1. Loose backbreak; our studies show an approximate 13 percent inefficiency in loose backbreak compared to solid material. However, with every other drill, the inefficiency was considerably more.
2. Ground under water; for example, where the water is at collar, or above collar.
3. Material close to the toe of a bank; this can be drilled without vibration and, if so desired, the machine can drill at the crest of a bank.

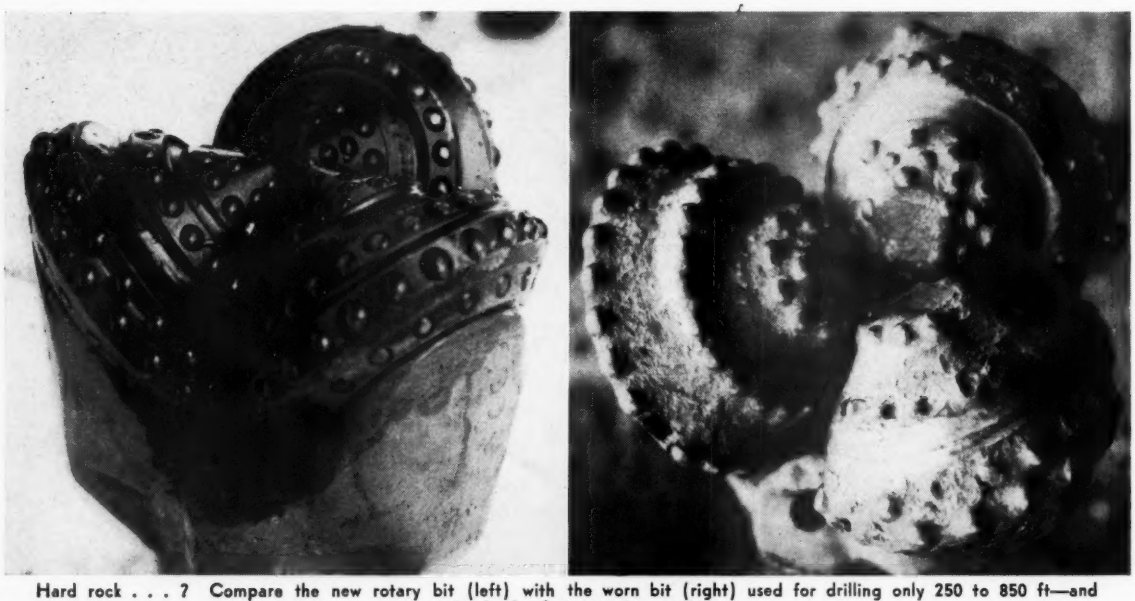
TACONITE DRILLING STATISTICS
Pilotac Mine
1952—1957
June 30, 1957

	Churn Drills	Rotary Drill	Jet Piercer	Air-Operated 6-in. Percussion Drill
1. Total Operating Shifts	5346	232	411	492
2. Total Actual Drilling Time—Hours	31690	1239	1897	2646
3. Total Delay Time—Hours	11056	639	1389	1290
4. % Operating Time	74.1	65.8	57.7	67.2
5. Total Footage Drilled	162388	19540	40730	29406
6. Rate of Penetration—Ft/Operating Drill Hour	5.1	16.0	21.5	11.1
7. Average Footage per Shift	30.4	84.2	99.1	59.8
8. Average Footage per Bit	11.2	630.3		234
9. KWH per Operating Shift (8 hrs.)	100	750	150	750

The rate of penetration is greatly reduced with the jet in the non-spalling taconites, with a proportionate rise in cost per ft, since process fluid consumption is fixed. Consequently, in jet piercing drilling, it is very important that a high rate of penetration be maintained if costs are to remain reasonable. An average rate of penetration in taconite would be approximately 23 ft per hr.

A recent improvement on the jet pierce drill is the Automatic Penetration Rate Compensating Control, now officially named the Yo-Yo, due to its probing cycle which determines the penetration rate correction for the succeeding cycle. It eliminates the human error in determining the rate of advance of the blow pipe. Our experimental work demonstrated a better than ten percent improvement over the manual control in good spalling rock. In other words, we are getting an increase of ten percent in footage for no additional cost except for wearing parts. The additional cost of the wearing parts is of small consequence. Contributions such as these are most welcome and several improvements such as this on a machine can easily turn failures into successes.

A good illustration of the fine spirit of cooperation between the operator and the manufacturer is exemplified by the development of the Yo-Yo. The operator and the manufacturer thoroughly discussed the manual operation problem. It was established that the rate of penetration was solely up to the judgment of the machine operator. Being unable to see down into the hole, the operator could direct too slow a rate of penetration with the cost of drilling increasing proportionately. The optimum position for the blowpipe is approximately four inches from the bottom of the hole. With the varying rates of advance due to spallability of the rock, the problem was how to keep the blowpipe in that position as much as



Hard rock . . . ? Compare the new rotary bit (left) with the worn bit (right) used for drilling only 250 to 850 ft—and not in the hardest taconite at that

Tough, massive taconites—hard enough to cut glass and weighing 2.4 tons per cu yd—are encountered in the Pilotac mine in northeastern Minnesota and present a difficult drilling problem

possible during the piercing operation. Manual operation could easily lead to tension for the conscientious operator. For the inefficient operator, costs could rise to an unreasonable high. The answer to the problem was the Yo-Yo. Cooperation such as this will do much to solve some of the many problems involved in the mining of taconite.

The example is mentioned to illustrate the splendid spirit of cooperation that exists between operator and manufacturer in the drilling of the taconites.

To be sure, in the drilling program at Pilotac there have been failures as well as successes. Nevertheless, from the failures, it has been possible to glean valuable information which has contributed in no small way to the successes. In general, we have found no formula for proving the effect of one variable in drill performance. The variable must be proven in the field. The experts on jet piercing tell us that they have no formula for determining spallability. Spallability can only be determined by actual testing. Much research is being done on the spallability of toconites.

Suspension Jet Drill Recently Developed

A more recent development in jet piercing is a suspension non-rotating blowpipe with a rotating burner which is capable of piercing holes to depths of 200 ft in fully spallable rocks.

The suspension piercing machine is primarily a churn drill with the tool string replaced with a suspension blowpipe and equipped with a control panel for metering process fluids. The prototype machine produces a minimum 5½ in. diam. hole. Subsequent passes, within limits, will produce larger diameter holes. In addition, this machine is equipped with a standard, easily changed, spudding tool to drill collars or break through melt seams encountered in drilling.

Because we may be able to drill a hole only as large or small as desired, within limits, the machine may prove successful in development, or sinking cuts, where holes are shallow and closer spacings are required. In general, we would have a hole tailored for a particular job. Field tests have been planned for this machine.

In good spalling material jet piercing costs, at present, exceed the cost of the churn drill by approximately 15 percent. However, with oxygen

(Continued on page 68)

DRILL DATA

Type Drill	Test Area	Total Ft Drilled	Ft/Shift	Ft/Bit	Ft/Hr (Drilling)	Ft/Hr (Gross Time)
7-in. Down-The-Hole	Hard Taconite	111	37	211		
Jet	" "	449	74.8	.....		
Rotary	" "	99.5	15.6	99.5		
Quarrymaster	" "	243	7.1	166		
7-in. Down-The-Hole	2/3 Hard Taconite—1/3 Slate	1430	64.32	436		
Jet	" "	1470	53.84	.....		
Rotary	" "	1720	52.84	501		
Quarrymaster	" "	260	28.26	355		
7-in. Down-The-Hole	Relatively Soft Taconite	2000	88	787	20	11
7-in. Down-The-Hole	Hematite Mine—Soft Rock	15,000	125.6	3000	28.8	15.7
6-in. Down-The-Hole	Frost	14,200	280	7000	58	35

PREVENTIVE MAINTENANCE FOR STEADY OPERATION

Total downtime of critical equipment at this Michigan salt mine for 1955-56 was 0.01 percent. This illustrates what can be accomplished when a good preventive maintenance program is followed closely. All phases of the mine's maintenance program—from organization to results—are described.

By **FRED W. PFAU**
Maintenance Superintendent
International Salt Co.

THE underground mine of International Salt Co., Inc. extends over an area of about 300 acres under the southwest portion of Detroit, and 1137 ft below the surface. The room and pillar system of mining is trackless and highly mechanized and faces are carried 60 ft wide by 22 ft high. 20-ton bottom dump trucks are loaded by 2½ yd electric shovels. The trucks unload into a large hopper, located ahead of a single-roll spike-tooth primary crusher. This crusher discharges on to a long conveyor belt which feeds the various underground crushers and screens for final preparation. After final preparation of the salt, conveyor belts carry the sized products from beneath a 3000-ton storage bunker, either directly to the skip hoist about a mile distant, or to a vast underground storage area of 100,000 tons capacity from where it can be reclaimed as desired.

Above ground operations consist of re-screening and bulk-shipping, synchronized with the tons per hr flow underground. If necessary the finished product can all be shipped either by railroad, highway trucks, or by ship during the Great Lakes navigation season.

Variety of Equipment Used

At this point, it is advisable to list the equipment that is maintained. The location of each piece of equipment is not given, except to distinguish between the surface and underground operations.

Underground

(3)	Type 512 Goodman undercutters	
(3)	2½-yd Marion shovels	For face loading
(2)	2-yd Marion shovels	For reclamation
(1)	Drill rig with four hydraulic rotary drills	For all face drilling
(1)	Loading rig	To load holes for blasting
(6)	Bottom-dump Euclid trucks (20-ton capacity)	For hauling from faces to primary crusher
(2)	Rear-dump Euclid trucks (10-ton capacity)	For utility hauling and stand-by for 20-ton bottom-dump trucks
(1)	Mobilized high platform rig	For roof scaling
(3)	2-yard front end Payloaders	To pile overshot salt for more efficient loading by Marions and for face cleaning
(13)	Automotive vehicles	For general usage
(1)	48-in. primary crusher	Single roll
(1)	36-in. secondary crusher	Single roll
(2)	24-in. tertiary crushers	Single roll
(6)	30-in. final crushers	Double roll
(4)	10-in. smaller double roll crushers	For recrushing any finished grades depending on demands
(6)	Scalper screens	
(6)	Final screens	
	Approximately 5 miles of belt conveyor	

Surface

(1)	Ottuma hoist	500 tons per hr capacity
(1)	Vulcan hoist	For personnel and material
(19)	Screeners for re-screening	
(2)	Box car loaders	
	Truck loading facilities	
(5)	Bagging stations with shuttle conveyors	For loading into railroad cars or highway trucks
(1)	Payloader equipped with coupling	To switch railroad cars to load stations
(1)	2-yd clamshell crane	For truck loading from outside storage
	Ship loading facilities and warehouse	
(7)	Automotive units	For general use

Maintenance Organization Clearly Defined

The subject of preventive maintenance has received considerable attention over the past few years. There is no longer much question of the value of preventive maintenance—although the degree to which it is employed varies extensively from plant to plant.

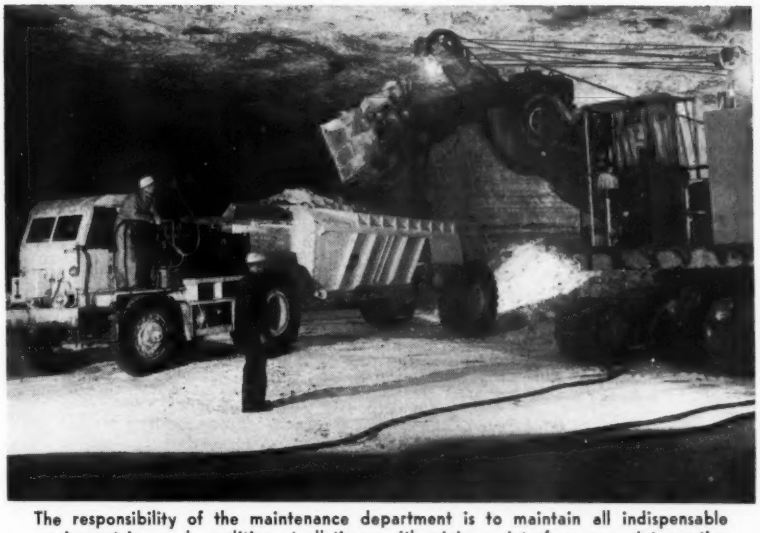
Centralized maintenance is preferable whenever possible. Unfortunately, 50 to 60 percent of International's force must do area maintenance. Work is done on swing shifts throughout the week—the swing shifts being set up in order to do preventive maintenance on equipment while it is not in use.

The maintenance department serves both underground and surface operations. The maintenance crew consists of 74 men: 59 are in the mechanical group and 15 in the electrical group, under the direction of six supervisors and the chief electrician. General direction of the entire maintenance group is by the maintenance superintendent.

The responsibility of the maintenance department is to maintain all indispensable equipment in good condition at all times with the minimum interference or interruption to the regular operation of the plant—to less important equipment we apply routine maintenance only. Of course, all equipment is lubricated as needed. Some less costly equipment such as small electric motors, conveyor idlers, and the like, are run to destruction and replaced with spares on hand. The responsibility of the maintenance group includes shaft and hoist maintenance, general housekeeping of the surface plant, and material handling of all maintenance and construction requirements. Considerable mechanization of the maintenance force over the last ten years has enabled the maintenance organization to cope with all responsibilities, in spite of increased production.

Adequate Facilities Vital

Two shops are conveniently located —one underground and one above ground. These shops are equipped with various machine tools, wood working tools, and welding equipment.



The responsibility of the maintenance department is to maintain all indispensable equipment in good condition at all times, with minimum interference or interruption to regular operation of the plant

They are sufficiently large to do centralized maintenance and some fabricating.

Adjacent to each shop are tool cribs and supply stores. Tool cribs are well stocked with all types of tools, systematically arranged and visible for easy checking. Supply inventories are handled on a maximum and minimum quantity, controlled by one inventory clerk located in the main office. Material is issued by storekeepers; and only by a requisition to stores which indicates the cost center where material is to be used.

As mentioned before, area work is done on heavy mining equipment, crushers, screens, conveyor lines, surface and underground storage facilities and the ship dock warehouse. This equipment must be maintained in these various areas. Several years ago this was a time-consuming problem. To do our area maintenance today is less difficult and more economical. This increased efficiency was made possible by the mobile facilities used by underground and surface maintenance men. These facilities are listed below.

Underground

(2)	Fully equipped 1-ton trucks including arc welding and flame cutting equipment	Used by mechanics for area maintenance and emergency repairs
(1)	Emergency maintenance truck	For automotive production equipment repair such as tire replacements and other minor adjustments
(1)	Fully equipped lubrication truck	To service automotive production equipment
(1)	Tank truck with compartments for water and fuel	For area and emergency maintenance
(1)	Fully equipped truck for the electricians	For maintenance supervision
(2)	Pick-up trucks	For high work by electricians and mechanics
(2)	Mobile elevated platform rigs	For general maintenance lifting
(1)	3-ton Hyster crane	For shop use
(1)	8-ton overhead bridge crane (40 ft wide with 180 ft travel)	
(3)	Arc welders mounted on 2-wheel trailers	
(3)	Compressors mounted on 2-wheel trailers	
(1)	35-ton low boy trailer	

Surface

(1)	Fully equipped truck, including arc welding and flame cutting equipment	Used by mechanics for area maintenance and emergency work
(1)	Arc welder mounted on a 2-wheel trailer	
(1)	Small tractor with power driven sweeper	
(1)	Small tractor with hydraulic front-end loading device	
(1)	3-ton overhead bridge crane (30 ft wide with 40 ft travel)	For shop use

With a background of 27 years in maintenance work with International Salt Co., Fred W. Pfau is well qualified to write this article on preventive maintenance. Pfau received his education in both German and American schools, and has also been employed in various machine tool and machine construction industries.

Experience Shows Paperwork Necessary

A quotation from the booklet, "Five Steps to Productive Maintenance," by General Electric Co. appropriately states the first rule in any work-order system.

> "All work done by maintenance *must* be covered by a written work order. Experience has shown that when written orders are neglected, work is often called for that is unnecessary, improper, or that has already been requested. Or, sometimes orders are issued for work that should be done at some other time because the proposed work relates to a larger job being planned somewhere. A written request lets you screen out unimportant or unnecessary work. After verbal requests have been turned down a few times, people will *stop* making them. A written request will establish responsibility, help prevent mistakes or misunderstanding about what is to be done, and provide the data necessary to accumulate costs."

About 95 percent of the maintenance organization's work is preventive maintenance, controlled and planned by a job order system under two classifications; (1) long term planned overhauls, and (2) routine maintenance.

Regular inspections are made by the assistant to the maintenance superintendent and the chief electrician. In most cases, long term overhauls originate from these inspections. Meetings are held in the maintenance office in order to plan these jobs thoroughly, including the estimated man-hours and material required.

Routine maintenance job orders originate partly by repair and maintenance record forms furnished with new equipment by the manufacturer, by inspections and by work requests from various other departments.

Visible tray cabinets are used which contain both equipment data cards and scheduled job orders. Blue-colored equipment data cards (one for each piece of equipment) are spaced sufficiently apart so that yellow-colored job order cards can be inserted directly below each of the blue data cards. Thus, at a glance the number of repairs pending for each piece of equipment is indicated. Upon completion of repairs the card remains in this file, but is marked completed. This in turn gives an up-to-date case history of each piece of equipment.

All job orders are made in duplicate. As described above, one copy is placed in the visible file with the equipment data cards and scheduled according to priority. The duplicate job order is filed in a bulk file numerically for easy reference and is posted on the shop job order board on the day before the job is to be started. A single visible tray is set up for jobs to be performed during a week. Job order cards are pulled by the file clerk from the master file according to priority tabs to make up this weekly schedule. The duplicate job order is issued to the various supervisors in charge who in turn will post the job order on the board, and schedule their men accordingly.

The supervisor, in planning his work for the next day, simply fills out daily time cards for each maintenance man from the job order. On this card are spaces for job order numbers and cost centers corresponding with similar data on job orders posted on the board. At the end of each shift the men fill in the number of hours worked on each job order, show the total hours worked and sign the card. All cards are approved by supervisors, sent to the maintenance office for payroll distribution and finally to the main offices for cost distribution by the accounting department.

Emergency Repairs Started in Five Minutes

Emergency requirements anywhere in the plant are phoned into the maintenance office in as much detail as possible. From this office they are dispatched to the shop foreman who directs a mobilized crew to make repairs. In most cases the repair crew arrives at the equipment within five minutes. Immediately after repairs have been made the maintenance crew reports the job completed to the maintenance office. The maintenance clerk then records the nature of repairs made and the actual down time of that equipment, on a monthly sheet. A separate sheet is used for each piece of equipment. These record sheets are very valuable to spot repetitive failures on a monthly basis which, of course, calls for action to eliminate them by more complete repairs or improvement if possible.

Maintenance of Key Equipment on Monthly Basis

Maintenance to indispensable equipment which was mentioned earlier in this article is conducted separately, and may be referred to as critical maintenance. Critical maintenance is applied only to equipment which would directly interrupt or delay production in case of failure. It is essential to perform this type of maintenance on a repetitive schedule, depending on the percentage of utilization of this equipment.

Scheduling of critical maintenance is done by utilizing the electric motor data file cards in a visible tray cabinet. The cabinet with data file cards for each electric motor and other electrical equipment was originally set up to facilitate preventive maintenance to electrical equipment *only*. Electric motors are frequently replaced so repairs can be made, and later installed on a different piece of equipment. Repairs and relocation are recorded on these cards, also giving us a case history of each electric motor. Attached to these motor file cards are colored indicators—a different color for each month. Electric motors and equipment whereon these motors are installed are selected for critical maintenance. Then a portion of the critical equipment is scheduled for each month throughout the year. Experience over the last two years has shown that this is an important phase of preventive maintenance.

Whenever a motor data card indicates work to be done, a repetitive job order determines the extent of inspection or repair. For example, a totally enclosed, sealed, ball bearing motor, will not be dismantled for five years, unless insulation tests or other circumstances warrant such measures. On the contrary, a coupling or a speed reducer connected to the motor may be dismantled once each year, or more often, depending on the type of service.

If defects are found to be serious, repairs are made immediately. Otherwise the general condition will be recorded on the motor, or equipment data card for future reference, or in some cases major overhauls are planned on a regular job order.

The only insurance to protect highly critical equipment is to stock parts which fail unpredictably. For example, brake linings, armatures, complete motors, speed reducers, and other principal replacement parts.

Mining is highly mechanized; optimum production depends on top performance from all equipment

Hoisting Rope Bears Special Attention

It is evident that one principal concern in mining operations must be the hoisting rope. The author would like to include in detail the preventive maintenance required for such an important device, from the time ropes are delivered and installed until the rope must be removed from service.

Inspection begins when ropes are first delivered by the supplier. The reel, on which the rope is coiled, is observed to detect any damage. The covering is removed from wire rope to check for proper lubrication, and the outer layer is also examined for damage to wires or strands.

A file card is then made for this rope whereon the general condition is recorded; including the reel number, exact outside diameter of rope, and date of delivery. The rope is then stored until the scheduled time of hoist rope replacement. These ropes are stored underground because of ideal and constant temperatures. By so doing, less frequent rotation of the reels is required to prevent drainage of the lubricant from the upper part of the coil. This can be important in case the rope is in storage for several months.

Ropes in service are inspected inch by inch once each week for broken wires, and decrease of outside diameter at critical points. Exterior lubrication is applied as frequently as necessary to keep wires covered at all times, to resist the corrosive conditions in a salt mine, and to reduce wear by friction.

The average total down-time for all types of equipment during 1955-56 was only two percent. Pictured is an undercutter in use at the mine face

Every three months the bight is cut off at the skip fastening which transfers heavy starting loads to a new section of the rope, and thus reduces wire wear at this critical point.

Ropes are removed, regardless of length of service, when at any time six broken wires should occur in one twist or pitch, anywhere along the rope. Otherwise, the ropes remain in service until they have hoisted one million tons or traveled approximately 25,000 miles—the equivalent of two years service for each rope. The life expectancy has been determined over the last 20 years by uncoiling sections of used ropes to establish the amount of corrosion of internal wires, and by determining the remaining tensile strength of used rope sections through tests made by the manufacturer.

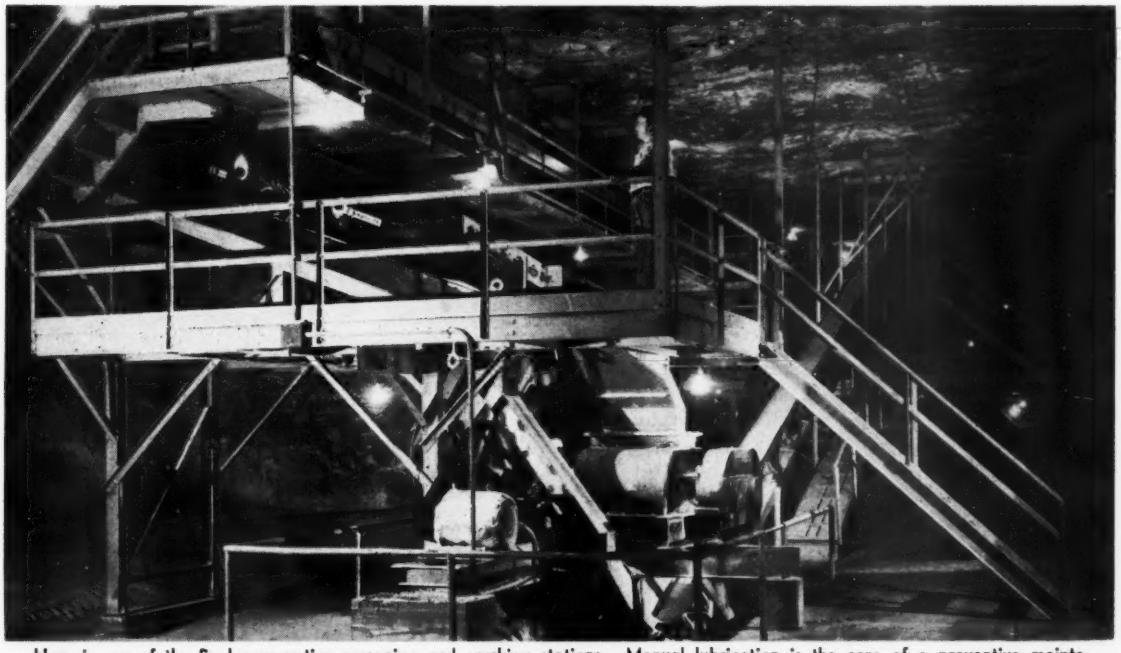
Lubrication Is Core of Success

It has been pointed out that all equipment is lubricated as needed. Manual lubrication is the core of good preventive maintenance success. All would fail if lubrication was improperly done. However, if automatic lubrication is used, the oil mist-spray type seems to be the most efficient and dependable. All-purpose lubricants, both oil and grease, are used except in extreme cases.

Fifteen years ago a lubrication program was set up for all equipment and assigned to oilers. Oilers are semi-skilled mechanics and are responsible for all lubrication, including the periodic oil changes in their respective areas. They repair all grease lines and fittings as needed, and make visual observations for any defects.

Almost No Downtime for Critical Equipment

Not to be overly optimistic it must be noted that the company still has emergency maintenance. But, the average of total down-time for all equipment combined during 1955-56 was two percent, and the total down-time of critical equipment—such as preparation facilities, main line conveyors, and hoisting and shipping facilities—for the same period was 0.01 percent. The latter percentage illustrates very clearly what can be accomplished when critical maintenance is applied to equipment.



Here is one of the final preparation screening and crushing stations. Manual lubrication is the core of a preventive maintenance program on installations such as this

A-C Power For Face Machines

A-C motors can be applied satisfactorily to almost any mining load. Where a-c motor characteristics seem to be inadequate, they may be remedied by torque converters and/or hydraulic pumps and motors

By C. C. CONWAY
Assistant General Manager
Clarkson Division
National Mine Service Co.

THIS nation continues to increase its usage of electrical energy at a phenomenal rate, and economists indicate that our industry will be called upon to produce increasing amounts of coal for many years.

The coal industry apparently recognizes that it must improve its productive facilities because there are new mines under development, others planned, and many existing operations in the process of modernization. Planning in almost every case involves consideration and application, where practical, of some form of continuous mining together with a concentration of mining.

Equipment is generally heavier, more powerful, and equipped with motors of greater horsepower than those previously used. The increased horsepower plus the concentration of mining causes the industry to have power distribution problems far more serious than those of just a few years ago.

Introduction of Electricity Into Coal Mines

The first use of appreciable quantities of electricity in coal mines was for haulage. Dewatering had for some years been accomplished by steam and compressed air, but it remained for electricity to take the burden of haulage from men and animals. To power haulage locomotives, it was found that the d-c series motor had characteristics which could not be approached in suitability by any other motor, either a-c or d-c. Its exceptionally fine torque characteristics, where the torque is proportional to the square of the line current, together with its ease of control, because the line current can be controlled by inserting resistance in the line, made it the logical selection to power locomotives.

With a-c unable to break into the locomotive haulage picture, the addition of electrical equipment into the industry came about as an extension to the existing d-c systems. In other words the electrical systems "just grew." When central d-c generating stations were unable to deliver sufficient power to the outlying loads, because of the necessity of transmission at very low voltages, then a-c systems at higher transmission voltage were added with step down transformation and conversion to d-c at points nearer the load.

Because power loads continue to grow heavier and more concentrated, it is becoming obvious to many in the industry that something must be done to overcome the handicap of voltage restrictions placed upon d-c and the difficulty of conversion at points near enough to load centers to allow good transmission with practical conductor sizes. Also there is the problem, as equipment connected horsepower continues to step upward, of getting trailing cables of sufficient conductor size to hold the potential drop within allowable limits, yet not too large for handling by reasonable means, and of finding sufficient room on mobile equipment to house and properly protect the contactors, resistance and other heavy and bulky parts required because of the heavy currents resulting with low voltage d-c.

A-C Motors Can Be Applied to Almost Any Mining Load

It is the purpose of this article to discuss the suitability of a-c motor characteristics to most underground mining loads and to discuss a general substitution of a-c for d-c insofar as practical. Before proceeding, the writer wishes to acknowledge that although the electrical industry has

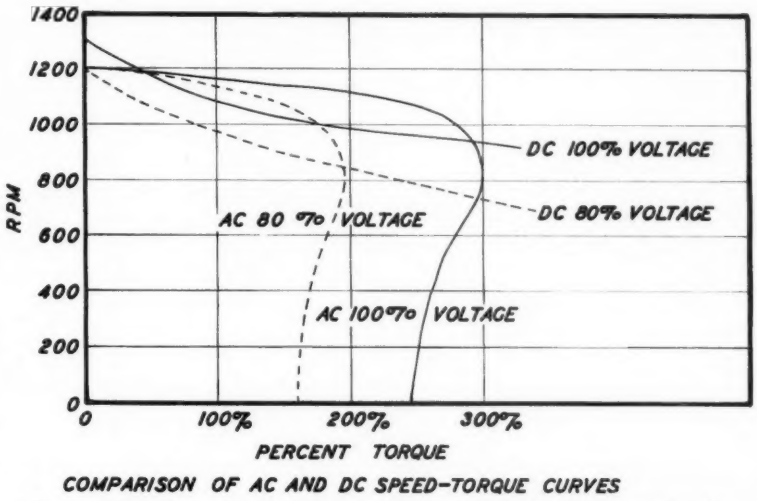
made great strides since the introduction of electricity into coal mines, it has yet to develop a motor, either a-c or d-c, with characteristics such that it will approach the suitability of the d-c series motor for haulage locomotive applications. The use of a-c on trolley locomotive, therefore, can be struck off with the further acknowledgment that even though mechanical drive assists were provided to make an a-c motor applicable, its use would still be out of the question because of the difficulty of transmission of single phase power to the trolley and rail. The concession that trolley haulage must necessarily remain powered by d-c is not as far reaching as it might seem because belt haulage, using principally a-c motors, has already taken a share of that work and at present writing seems destined to make further inroads toward performing both primary and secondary haulage.

There seems to be no difficulty in reconciling a d-c system of haulage with an a-c system of mining except for the haulage directly from the loading unit. It seems desirable not to intermix a-c and d-c at the face but this appears not to present difficulties. Present best practice in face haulage consists of the use of some form of conveyors or more commonly of shuttle cars. Conveyors are of course an acceptable a-c application, and fortunately shuttle cars have recently been developed so that they may be equipped with either a-c or d-c motor and control and operated with equal success.

On face equipment, now most commonly powered by d-c, the larger motors are usually compound wound to give the desired speed characteristics, but often one or more smaller motors are provided to perform operations which might be classified as tractive. These special operations usually require abnormal torque characteristics perhaps not readily obtainable with a-c by ordinary means but easily handled with the help of special devices such as torque converters and/or hydraulic pumps and motors. In fact the performance of hydraulic equipment is so acceptable and desirable that it is a standard part of most mining machines. Since hydraulic pumps are so well handled by a-c, usually simpler and more effectively than by d-c, the chief concern in the powering of a-c equipment lies in the selection of the main power units.

Characteristics Compared

The characteristics of a-c and d-c motors have often been compared, but for review some of the important points will be repeated. Because the first task of a motor is to start the connected load, it is perhaps best to first consider the two motors from the standpoint of starting torque. D-C motors are inherently flexible as to control of starting torque. D-C motor starting torque is proportional to the starting current which in itself has only one practical limitation—that it be not great enough to cause flashover and damage at the commutator and the brush holders. This current is controlled by starting resistance and can be in as many steps as space can be allotted for contactors, timers, resistors and associated items. A-C motors, considering only the squirrel cage motor as the wound rotor style of equipment is not usually applicable to mobile type face equipment are started directly across the line with an absolute minimum of control equipment and control space requirements. The a-c motor, however, must be designed to have the desired characteristics and once selected are thereafter fixed. In the design of an a-c motor the starting torque must be selected as a compromise with other characteristics including the pullout torque. Selection of very high starting torque results in low power factor, low efficiency and poor regulation. All of the above follow chiefly because high rotor resistance is required for high torque, but the resulting high slip is detrimental to power factor, efficiency and regulation.



COMPARISON OF AC AND DC SPEED-TORQUE CURVES

Fig. 1. Chart shows the effect of low voltage upon speed torque curves for d-c compound wound motors and squirrel cage induction motors. While the d-c motor drops off badly in speed, it still maintains its torque. On the other hand, the a-c motor maintains its speed but its pullout torque is greatly reduced

Figure 1 is presented to show typical speed torque curves for d-c compound wound motors and squirrel cage induction motors. The effect of low voltage upon the speed torque curve is shown by the dotted line plotting of 80 percent voltage operation. This serves to point out that, while the d-c motor drops off badly in speed (rpm is roughly proportional to the voltage), it still maintains its torque. Also, that while the a-c motor maintains its speed, its pullout torque is greatly reduced (a-c motor pullout torque is proportional to the square of the voltage). On figure 1 it is to be noted that the d-c curve might be extended to greater torque, with further reduction of speed, but the increased torque would be with armature currents approaching flash-

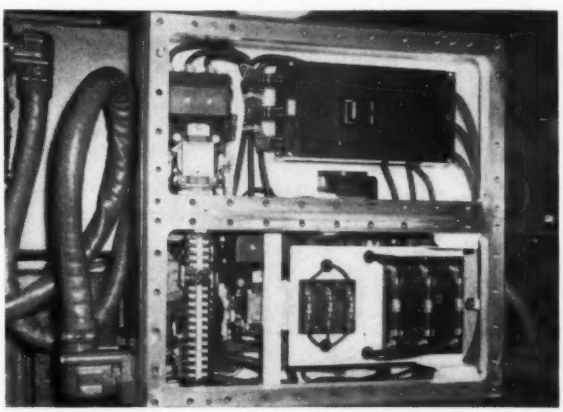
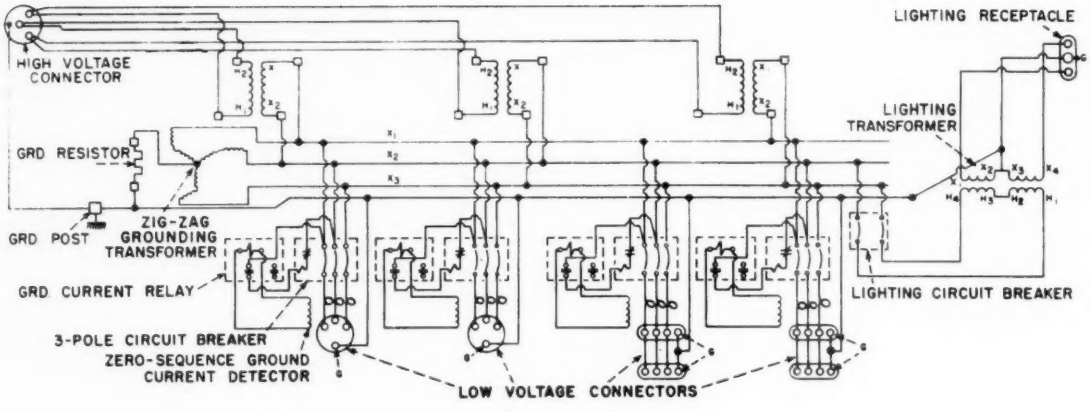


Fig. 2. This typical 3-phase 440-volt motor control illustrates the economy of control space that has been achieved by the use of a-c



Internal wiring diagram

Fig. 3. In this mine power center where the primary and secondary are connected delta, zig-zag transformers are used to establish a neutral and a grounding resistor is added to limit ground currents to approximately ten amp. Each circuit breaker on the secondary side is equipped with a ground detector and relay to open that particular circuit in the event of a ground fault

over values. In other words, to start the d-c motor in figure 1 it would be necessary to use resistance at starting so as to limit the current below that sufficient to cause flashover or other damage. As speed increased, torque would fall off but would be restored by cutting out resistance so that eventually the d-c motor would reach its full speed with good torque all of the way and with armature current held reasonably low, providing the control was operating properly.

While the starting of a d-c motor can be and usually is accomplished without exceeding two or three times normal current, the a-c motor may require six or more times normal current. By the very design of the a-c motor, however, the current required to start the motor, at any voltage, is fixed and the sole variable under fixed voltage conditions is the time of acceleration which is determined by the friction and inertia of the load. The above is not true of the d-c motor where the current demand and the rate of acceleration are additionally determined by the control equipment and its adjustment up to the point of failure of either the motor or control. The a-c motor lends itself to less driven equipment damage as well as less damage to motor and control during starting periods. Thus, torque limitations of the a-c motor may well be to our advantage when we apply them to drive mining equipment.

Characteristics of the a-c motor are such that the control is very simple. In fact the usual method of starting motors used on face equipment is by line starting so that only a single contactor per motor is required, although of course short circuit and overload protection must be provided. Figure 2 is presented to demonstrate the simplicity and meager space requirements of a typical 3-phase 440-volt motor control. This particular control is for two 70 hp and one 50 hp motors and includes a one-kva transformer for isolation of the control circuit plus low voltage for headlights. When it is considered that the entire control is housed in the enclosure shown—that is, there are no other enclosures for resistors or other accessories—it is apparent that economy of control space has been achieved by the use of a-c.

The discussion of the adaptability of a-c motors might be continued, but such troubles as may exist come about because of the starting current. Since this brings about a distribution problem, it seems best to discuss that phase of a-c mining.

Principal Problems in Distribution Are on Secondary System

Distribution of power in a-c mining might be divided into two separate problems. First consideration would be the primary distribution, usually from one central metering point to the individual power centers. This would not be too different from the problem of distribution to d-c conversion centers, other than it is likely that a a-c there would be more centers and placed closer to load centers. This statement is made because, as will be shown later, there are certain problems in the secondary distribution which make it desirable to extend the primary very close to the load center so that in many cases existing d-c load groups might be divided into smaller groups. Otherwise the primary system should not be materially affected, providing it is adequate where the expression adequate is used to describe a system that fills every need including reliability, flexibility and capacity.

While the primary distribution may not be affected, the secondary system presents many new considerations. First, a-c motors require better voltage regulation than d-c motors, as do also their control. The particular problem is that a-c motors as stated before require six or more times full load current for starting. This heavy starting current causes heavy voltage drops in the power system so that there are three principal results:

A. Contact tips of the starter may blister and burn because of improper sealing. A-C contactors are guaranteed to pick up at 85 percent voltage, but at that voltage there may be some bouncing and conditions are not most favorable for high inrush.

B. The voltage drop may become great enough so that the contactors drop out. While a-c contactor drop out voltage is considerably less than the 85 percent pick up voltage, it is generally considered that the regulation should not exceed 20 to 25 percent at starting.

C. Torque may be reduced to such extent that the motor may fail to start (because torque varies approximately as the square of the voltage so that 80 percent voltage allows only 64 percent starting torque).

The situation is eased by the fact that a-c power centers are very easily established so that they may be placed immediately adjacent to any large loads and the secondary cable lengths thereby held to a minimum length. In other words on-the-spot centers are possible so that if two sizeable loads are to be served, then they must each be within reach of a relatively short secondary cable or they are handled by separate power centers. This is practical principally because an a-c power center does not involve the ex-

pense of an equivalent size d-c conversion unit. Neither does it involve the rotating equipment balanced circuits and other such components which usually require skill and highly trained personnel. It does not have the weight and does not require the elaborate housing of d-c conversion equipment. In short it requires only a transformer with certain circuit protection, which has become more or less standardized, so that the manufacturer need only know the number of pieces of equipment to be served, the size of each, and the total load so that a package unit may be prescribed.

Figure 3 is an internal wiring diagram of a mine power center where the primary and secondary are connected delta. Zig-zag transformers are used to establish a neutral and a grounding resistor is added to limit ground currents to approximately ten amps. Each circuit breaker on the secondary side is equipped with a ground detector and relay to open that particular circuit in the event of a ground fault. Note that the center is equipped with a high voltage connector, low voltage connectors for each secondary circuit, a lighting circuit breaker, lighting transformer, and a 110 x 220 volt lighting receptacle.

Power centers such as the one shown in Figure 4 are available as standard catalog items in capacities up to 300 kva. The usual voltage ratings are 4160/2400 primary, 240 x 480 delta secondary, but they are available for wye connection on the secondary where it is felt that the neutral must be fixed and not derived. It would seem that the freedom to connect the primary in wye so that the neutral might be either grounded solidly or resistance grounded would make for the better system and, therefore, the delta connected secondary with the zig-zag established neutral should be desirable. Ventilated-type mine power centers like the one shown in Figure 4 and briefly described in these paragraphs weigh about 4500 lb for the 300-kva unit, are mounted on skids, can be suspended from the end for swinging in shafts, are available at extra cost on trucks or dollies and otherwise are very versatile, flexible, rugged outfits. Compare the price at less than $10,000 with an equivalent sized rectifier and the economy of a-c power centers become apparent. Of course small d-c conversion units, except dry plate rectifiers are not economical, but two 300-kva a-c units have less than half the cost of one 500-kva d-c conversion unit. They are much more flexible in that they can be readily moved and kept adjacent to two load concentrations, whereas the conversion unit must be held in such position as to serve the same two concentrations as best it can, even though they become badly separated. It might be mentioned that motors, control, and cable are more economical for a-c than for d-c, with the cost of cable being reduced solely because of the lesser amount required.

Fig. 4. This ventilated-type power center is a standard package unit with four secondary breakers plus the breaker for lighting

Safety

Any discussion of a-c and its suitability in coal mining should include some discussion of its relative safety and also its general acceptance by regulating bodies, namely the Bureau of Mines and the individual state mining laws. Considering the safety angle first, it must be remembered that any success with a-c secondary distribution must come as the result of keeping the conductors workmanlike and in cables. Separating the individual wires by as much as a few inches, through any appreciable distance, will so increase the reactance that suitable voltage regulation would be impossible. The possibility of individuals getting line to line voltages are less remote than with d-c. The line to ground voltage at transformer voltage of 480 a-c is only 273 which, of course, compares with 275 d-c, but then also the ground fault current is limited by ground current resistors to about ten amps. so that serious burns to personnel become less likely. The danger from fire is also greatly reduced by the minimum ground current.

One of the greatest difficulties with d-c distribution and usage has been in the past, and continues to be, the fact that load currents, as the result of low voltage, are so heavy that the earth often becomes a part of the return circuit and stray currents are common. Ground trip devices fail to operate properly and grounding cables connected to mobile equipment often causes that equipment to be above earth potential by voltages sufficient to cause discomfort to the operator and dangerous arcing to the earth or other pieces of equipment at earth potential. This is not a problem with a-c where the power conductors are not grounded and the earth does not become a part of the power circuit. Where a-c is used it is the general practice to provide ground trip devices to remove any circuit from the line at the instant that the first ground occurs. Ground conductors under these circumstances are really practical, and equipment may well be maintained at earth or near earth potentials.

With respect to rulings of state and Federal groups, the situation may be summed by saying that, while some states have 250 or 275-volt d-c limits, those responsible for the enforcement of regulations are in some cases authorized to permit special voltage and circuit arrangements which will permit safer mining of coal. These people have in several instances acknowledged that a-c at higher voltage is apt to be safer than existing systems and have permitted trials which to date have verified the safe operation promised by initial studies. Well planned, safe and adequate systems are apt to receive favorable action, and it is then the duty of those concerned to proceed with strict adherence to good practice. Insofar as the Bureau of Mines is concerned, it might be mentioned that they are on record as being agreeable to the approval of certain types of equipment with a-c terminal voltage up to 650.

Selecting Cable Sizes

Because voltage regulation is so important in a-c distribution, figures 5, 6, and 7 will prove of interest. These curves are taken from and are essentially the same curves as presented in an American Mining Congress power committee report of 1946. With the help of these curves, and they are only a part of the complete report entitled "Alternating Current Transmission and Distribution for Mines," it is possible to select cable sizes required for various a-c primary and secondary applications.

Figure 5 is self explanatory and is of assistance to those who have occasion to make power factor and power factor correction calculations. Figure 6 allows the selection of suitable cables, considering the problem strictly from a thermal standpoint, while figure 7 is helpful in selecting cables suitable for a particular application where the consideration is solely one of voltage drop. Suitable cable must, of course, be within the limitations prescribed by both curves, and the usual practice is to select a cable

having sufficient thermal capacity and then checking to see that the voltage regulation is within the allowable limits.

Referring to figure 7, it will be noted that the basis of loading calculation is by kwd where kwd is the product of the kw load and the distance in thousands of feet. When the kwd has been determined, it is divided by the allowable percent of regulation to determine a unit kwd. Referring then to figure 7 and the proper column according to voltage, the unit kwd point is located and projected horizontally to the right to a point of intersection of the proper vertical power factor line, and the conductor size is thus located as the curve on or immediately above the located point. Attention is called particularly to the flatness of the curves for the smaller sizes of wires so that power factor does not play its usual important part. This is because the currents for small wires are comparatively low and because the center to center distance of the individual conductors is also very low. Small wire sizes are, of course, only possible with very light loads, or, if the loads are heavier, when a high voltage is utilized.

With the help of figures 5, 6 and 7, it is possible to select cable sizes required for various a-c primary and secondary applications

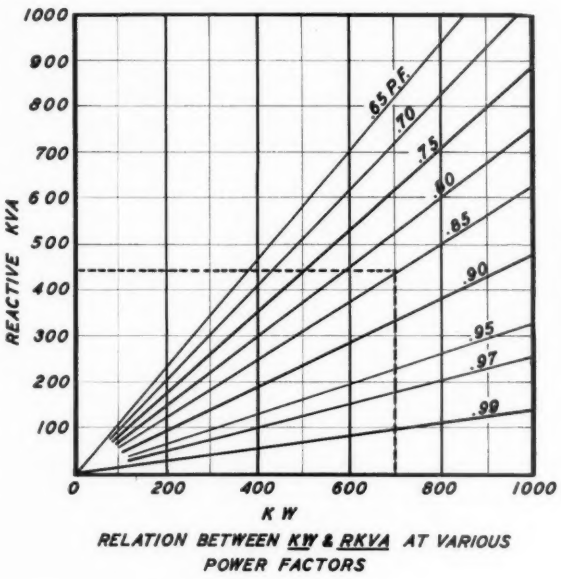


Fig. 5. Assists those who have occasion to make power factor and power factor correction calculations

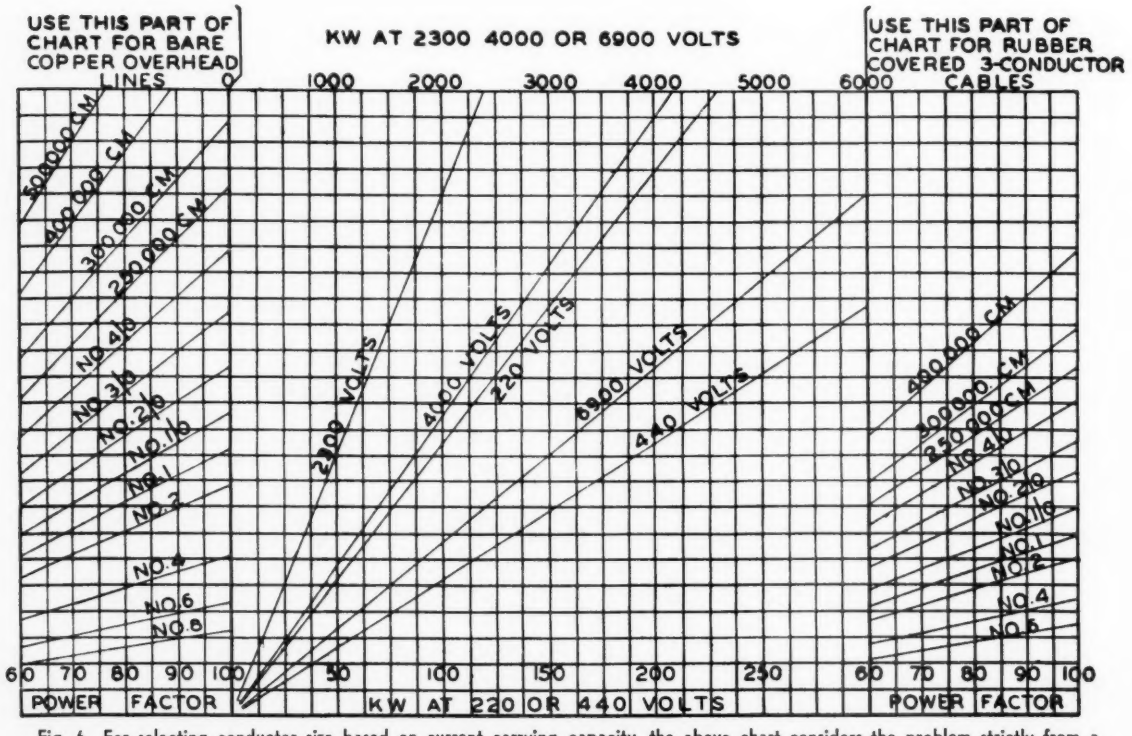


Fig. 6. For selecting conductor size based on current carrying capacity, the above chart considers the problem strictly from a thermal standpoint

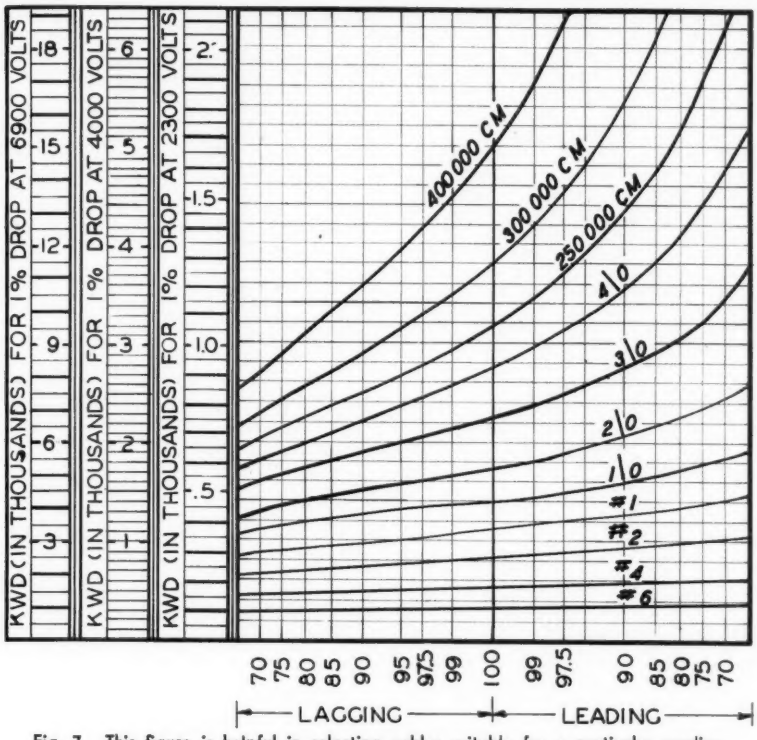


Fig. 7. This figure is helpful in selecting cables suitable for a particular application where the consideration is solely one of voltage drop. Suitable cable must of course be within the limitations prescribed by both figures 6 and 7, and the usual practice is to select a cable having a sufficient thermal capacity and then check to see that the voltage regulation is within the allowable limits

In Figure 8 the distance of transmission is plotted against the regulation for certain set conditions. The conditions are that the transmission is by 600-volt cables with the cable size at 4/0 A. W. G. and the load at 200 kw. The curves then indicate the percent of regulation at any power factor and distance. The principal plottings are at 220 and 440 volt, and it will be noted that for any given drop the allowable distance is increased four times when the higher voltage is used. The dotted line to the right has been added to indicate 100 percent PF regulation under the same conditions but at 550 volts.

The conclusions of this article are that a-c motors can satisfactorily be applied to almost any mining load except trolley locomotives and that the torque characteristics can be advantageous in most cases. Where a-c motor characteristics seem to be inadequate, they may be remedied by torque converters and by conversion to hydraulic energy. The principal problems in distribution are on the secondary system and involve regulation during starting. Finally, 220-volt a-c is too low to be practical, 440 volt is a minimum acceptable voltage and 550 volt should be advocated.

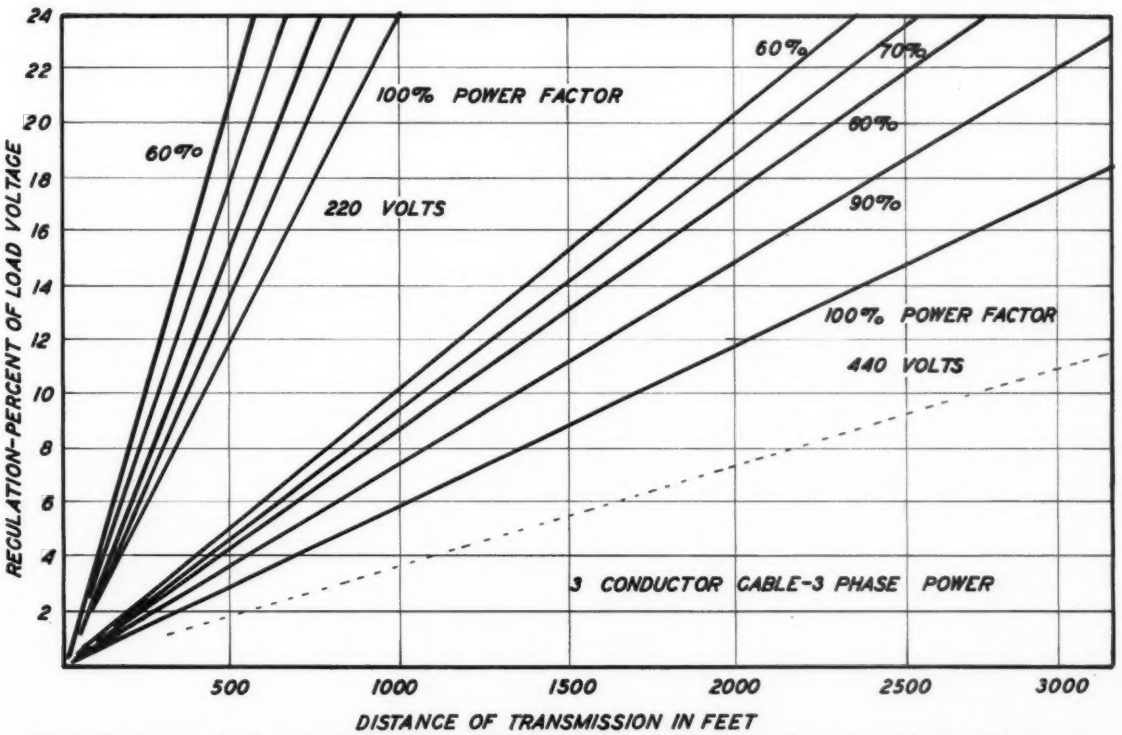


Fig. 8. The distance of transmission is plotted against the regulation for certain set conditions—transmission by 600-volt cable with cable size at 4/0 A.W.G. and the load at 200 kw. The curves indicate the percent of regulation at any power factor and distance. The dotted line to the right has been added to indicate 100 percent PF regulation under the same conditions but at 550 volts

A Discussion of Fine Coal Recovery Equipment

Is it cheaper to mine additional coal than to recover the fines in the preparation plant?

If the fine coal is recovered, is there a market for it?

What equipment is available for recovering and cleaning sludge?

By WILLIAM C. McCULLOCH

Coal Preparation Manager
Roberts & Schaefer Co.

PARAPHRASING the words of Mark Twain about the weather, it may be said that everybody talks about the sludge problem, but very few people do anything about it. As a representative of a manufacturer, the writer feels justified in stating that there need not be a sludge problem if those responsible are willing to spend the money necessary to correct it. There are available to the purchaser the types of equipment that will permit closing the water circuit if he will only take advantage of the proven processes.

Problems of Fine Coal Recovery

The recovery of fine coal or sludge has always been a debatable subject. First, by definition, it is not always sure what is meant by fine coal. Second, in market value, producers may not be able to find a customer who can use it. Third, in economics, it may be cheaper to mine additional coal than to recover the fines in the preparation plant. Fourth, the type of equipment available may not be suitable for every condition.

Let us then try to define what is being discussed. It is within the personal experience of many of us when anthracite pea coal was considered unsalable and culm banks of that region may still be found with pea coal as a waste product. Similarly, many of us have seen vast accumulations of so-called carbon sizes around bituminous mines awaiting some favorable market condition. In today's terminology, however, fine coal has a different meaning. Fine coal may be only that product which is wasted to the streams or sludge ponds or as dust to the atmosphere. These products may vary, however, in different coal fields and in different preparation plants in the same field. Before an attempt can be made to discuss methods and equipment to recover fine coal, its value must be established. If the fine coal is to be recovered merely to throw away, the problem would be approached differently than if it were to be recovered for sale.

The literature of coal cleaning is replete with information about equipment to clean fine coal, and many excellent plants have been built for that purpose. However, with rare exceptions there is always a slurry that is escaping to cause pollution of streams. It is with this waste product that the article shall be concerned.

Obviously, the market will not absorb the recovered coal as a product. It must be blended with the coarser sizes in order to make it salable, and even then it may vitiate the burning properties of the mixture so that it is not acceptable. Exceptions to this may be noted particularly in coking coal for metallurgical purposes or steam coal for powdered coal or suspension burners. A specific instance in which dust can be marketed profitably is in the foundry industry, where bagged dust from the dust collectors of air-washing plants is used for foundry facings or sea coal.

Many Processes

If a place is available to dispose of the sludge, there is little doubt that it is cheaper to get more coal from the mine than it is to recover coal from the waste water. This is particularly true in flat country where it is easy to impound an area for sludge accumulation. There are very few instances where it has been practicable to recover sludge from ponds once it has been accumulated. The obvious approach is to process the slurry in the plant to avoid the accumulations. In the many instances where the streams have been polluted, legislation is gradually enforcing an improvement and it becomes necessary to recover the fines if only to add the product to the refuse. With this enforcement, the economics becomes a secondary issue, but if it is necessary to close the washery circuit, then the desirable thing is to recover the fines with a satisfactory quality so that it may be blended with the washed coal.

The equipment required for fine coal recovery may be of several types, and the one which works successfully at one location may not be satisfactory at another. In the category of

simple reclamation, there are the many types of thickening and filtering. In the category of cleaning, processes include froth flotation, convertol, slime tabling, jigging in its several forms which include felspar, ORC, and Baum type with low capacity ratings, and classification. In classification, a size separation is effected which frequently gives an improved quality by removing extremely small particle fines in the range of 325 mesh or 44 microns.

Let us try to evaluate the processes and limit the scope of each. The writer has passed over vibrating screens, basket-type centrifuges, concentrating tables, Rheolaveur launders, and sludge tanks as being outside the range of sizes that he has defined as sludge. In some instances these processes may have some advantage in properly conditioning the effluent of undersize so that it may be more readily treated in additional equipment. However, it may be assumed that the slurry is dilute and must be thickened to facilitate recovery.

Air cleaning, where applicable, avoids any of the sludge problems that are inherent to all wet-washing processes

Gravity Method—for Complete Recovery

For complete recovery there is only one method and that is gravity. This takes thickeners of the type manufactured by Dorr, Hardinge and others, and having sufficient area to provide clear water overflow. In those instances where colloids prevent complete settlement, flocculating agents must be added.

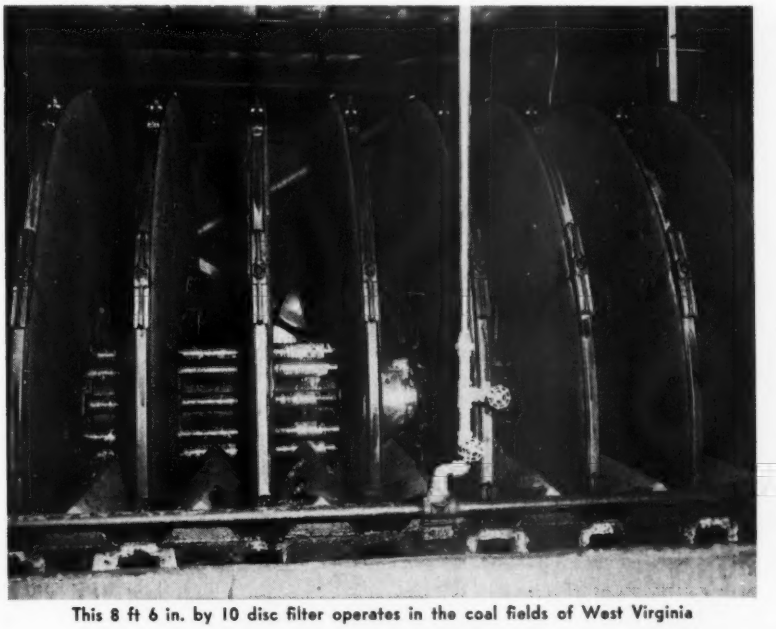
For nearly complete recovery, cyclones or solid bowl centrifuges may be employed. In these processes the final separation is of the order of 325 mesh and the waste product is greatly reduced. When conditions are favorable, the extreme fines may be expected to escape by being painted on the coarser particles, and there is essentially a closed circuit. Several suppliers may be found for the cyclone-type thickeners, but the Bird Machine Co. is essentially the only manufacturer of solid bowl centrifuges.

Following thickening, filtering must be provided. There are numerous types with several manufacturers—disc, top feed, horizontal and drum filters produced by such manufacturers as Door-Oliver, Peterson Filters, Denver Equipment Co. and others.

In a typical washing plant with a throughput of 500 tph, enough capacity to handle 2000 gpm of slurry containing 35 to 45 tph of dry solids may have to be provided. The disposition of these products depends on the other factors in the preparation plant, but the company would expect to reuse the water. Facilities should be provided to divert the filter cake to either clean coal or refuse depending on its ash content. The moisture content is also variable but usually is in the range of 20 to 30 percent surface moisture.

The final waste product with solid bowl centrifuges or cyclones in a similar typical plant would probably not exceed 1.0 percent or five tph and the recovered coal would have less moisture and less ash than above because of the natural characteristics of the extreme fines which would be removed. Subsequent thickening and recovery of this final waste product is basically an unsolved problem because of difficulties in handling this type of material. Further, if it is colloidal, it may require the addition of flocculants even in storage ponds to permit the reuse of the water. A typical flocculant for this purpose is prepared by the Dow Chemical Co. under the name of Separan.

Assuming that management evaluated the quality of the sludge and the cost involved, it may wish to combine cleaning with recovery of the total products. In this instance the original flowsheet of the plant in question has a direct bearing on the treatment required. For instance, simple Baum-type jigging with controlled capacity ratings may suffice to clean the sludge for practical purposes. Tabling with limited top size in the feed to resemble slime treatment may be all that is required. Felspar jigs, or more recently the ORC jig with natural raw material for forming the false bed, do an acceptable job. The Hydrotator-classifier not only deslimes but recovers fine coal cleaned and partially dewatered.



This 8 ft 6 in. by 10 disc filter operates in the coal fields of West Virginia

Efficiency of Froth Flotation

The technology of froth flotation, the ultimate in fine coal cleaning, dates back at least 40 years. In the library of the University of Washington there is a thesis written by the author of this article in 1922 describing research work on coal with froth flotation. However, it was several decades too early and it is only in the last few years that commercial plants utilizing this process are found. It is unnecessary to describe the various types of equipment, but the most popular machine is the Denver Sub. A. Others in use are the Wilmot Hydrotator froth flotation cell and the Galigher Agitair. Although our terminology is simplified by referring to the machines, a process is actually being discussed, and consideration must be given to preliminary preparation, reagents, conditioning units, frothing cell, froth breaker, and finally the dewatering of both the coal and refuse tailings. The description of these tanks or cells or a discussion of the physical principles of the reagents is more extensive than the scope of this article.

Froth flotation is the only process in use today that affects coal cleaning in even the very finest sizes. Although some plants may deslime the feed, it is common practice in European plants to clean the coal down to zero.

In evaluating the benefits of froth flotation, the reduction in ash that is possible must be established. Since this varies with each seam of coal and each mine, the writer can refer only to typical installations.

The commonly accepted float-and-sink method of testing does not apply because no laboratory procedure has been evolved that will give good specific gravity separations. The final ash value then is our only method of measurement. It is not unusual to have a final clean coal ash equivalent to that of the float ash in the coarser sizes, and the tailings ash is of an extremely high percentage. To be specific, there may be five or six percent of ash in the recovered coal and 75 or 80 percent of ash in the tailings.

Depending on the percentage of impurities in the raw product, the feed ash may have been as high as 20 or 30 percent.

The clean coal when filtered is no higher in moisture than the uncleaned filter cake.

Disposal of the tailings in a closed circuit plant takes on a different form. It is necessary to flocculate the particles for thickening and subsequent filtering. If the character of the material presents difficulties for continuous filters, plate and frame batch filtering may be used. This method is not uncommon in froth plants in England, but the writer knows of no such installations in America. In other instances froth tailings makes a suitable material for heavy medium processes.

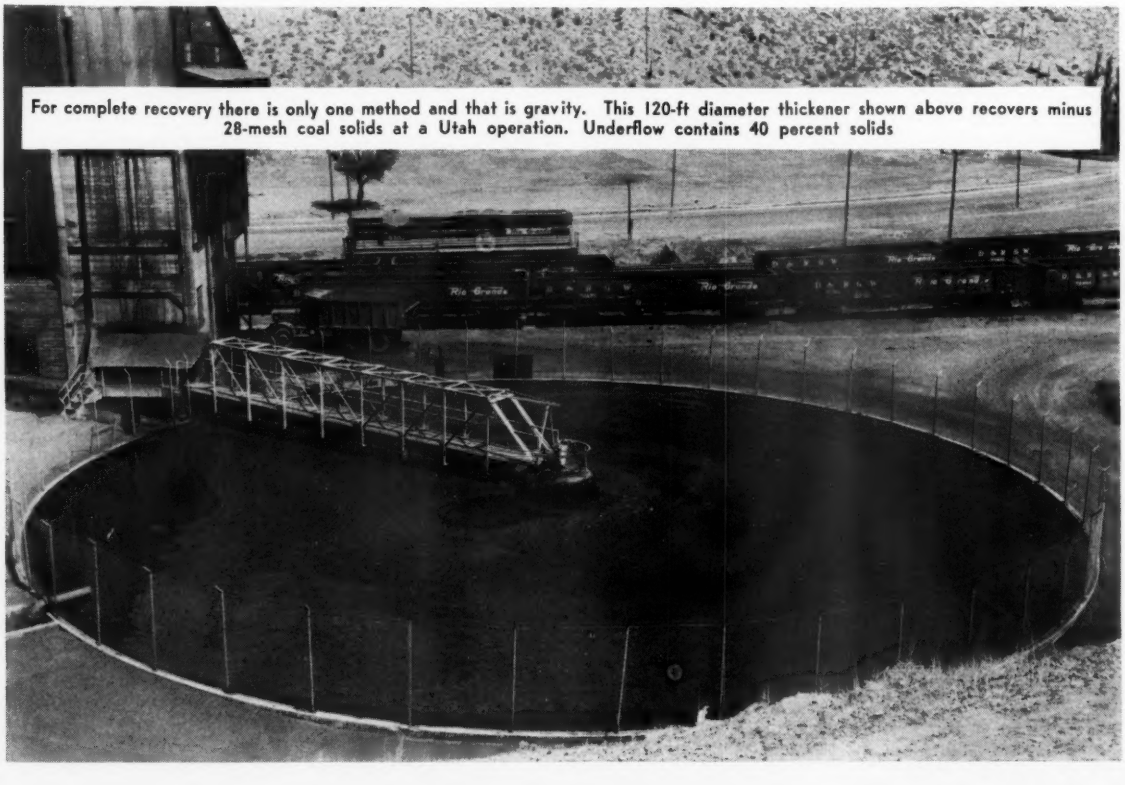
Additional cost of the froth flotation plant to recover low ash coal, assuming the company already has the thickening and filtering equipment to recover the raw slurry, is very low. A recent instance of this kind is the Crucible plant of the Crucible Fuel Division, Crucible Steel Corp. Addition of frothing equipment was a relatively minor project to a plant that had cyclones, thickeners and filters. The cost of reagents is negligible when compared with the benefits of the cleaner coal.

Another process known as Convertol has been reactivated after several years with a prototype plant built by U. S. Steel Corp.

Air Cleaning

The alternate approach, air washing, eliminates the sludge problem and keeps the coal out of water. There is obviously no reason for replacing ash with moisture in the present market when so many of the coal contracts are based on as received Btu values.

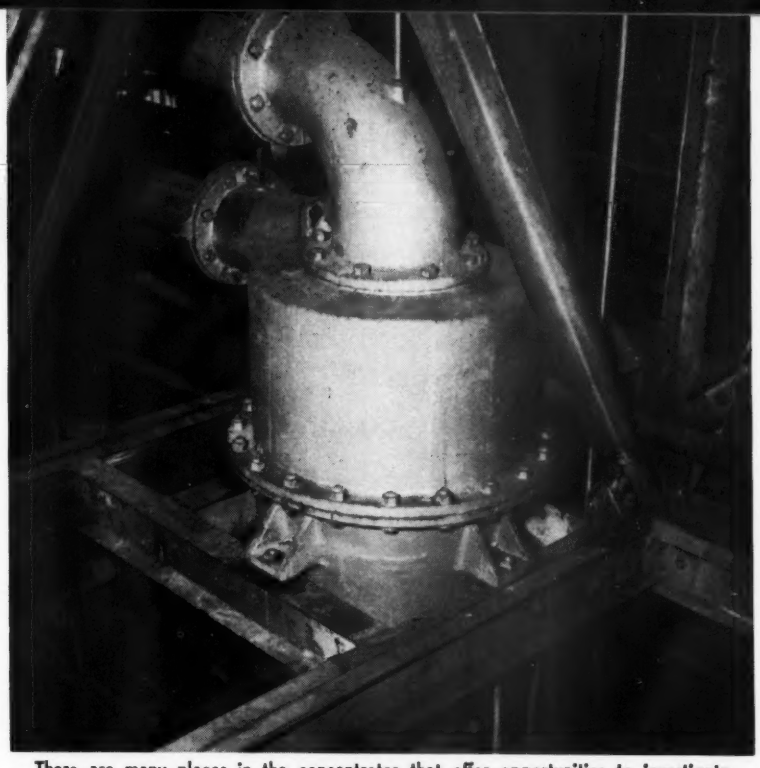
In the present stage of development of air-washing equipment, a practically complete removal of the high ash and surphur impurities can be expected in most coal. There is no bone separation with air as the medium, but it is the exception when this is the final requisite of coal preparation. The ordinary type of installation of Airflow equipment as manufactured by Roberts & Schaefer Co. effects cleaning down to about 48 mesh. Below this size no improvement in ash is noted, but the fine sizes are available for mixing with the clean coal on a 100 percent recovery basis and any of the sludge problems that are inherent to all wet-washing processes are avoided.



For complete recovery there is only one method and that is gravity. This 120-ft diameter thickener shown above recovers minus 28-mesh coal solids at a Utah operation. Underflow contains 40 percent solids

CYCLONE CLASSIFICATION at Chuquicamata

By D. S. SANDERS
Concentrator Superintendent
Chile Exploration Co.



There are many places in the concentrator that offer opportunities to investigate the possible advantages of cyclones

Using cyclones in place of spiral classifiers, the present set-up of ten rod mills and ten ball mills can be changed to ten rod mills and fifteen ball mills—without an increase in plant area. As a result, grinding capacity is expected to increase from about 38,000 to 45,000 tons per 24 hr

THE Chuquicamata mine and reduction works are owned and operated by the Chile Exploration Co., a subsidiary of The Anaconda Co., and are located at Chuquicamata, Chile, about 150 miles inland from the Pacific Ocean port of Antofagasta, in northern Chile.

Although the Chuquicamata mine and Oxide reduction works have been operated since 1915, it has only been within the last fifteen years, as the oxide ores were removed in the upper levels of the great open pit mine, that the sulphide copper orebody has been uncovered and developed. As the sulphide ore zones were exposed, several million tons of sulphide ores were mined and placed in stockpiles, which since have been treated in the present concentrator.

Construction of the sulphide copper ore treatment plants was started in 1948 and the first of ten equal sections in the concentrator was placed in operation in July, 1952. By January, 1953, the entire concentrator was in operation, and about 25,000 short tons of ore were being treated daily. This tonnage has been increased gradually, until, today, the normal capacity of the concentrator is rated at 38,000 to 40,000 short tons per 24 hr. The principal changes which have helped to increase capacity have been the introduction of a coarser grind to the flotation section and the production of a finer feed for the grinding circuit, together with various changes in the grinding loads, mill speeds and the classification and controls.

Present Grinding Circuit

The present complete grinding circuit in each of the ten sections consists of one 10 by 14-ft rod mill with a scalping rake classifier, and one 10 by 12-ft grate discharge ball mill in closed circuit with two duplex 54-in. spiral classifiers. The rod mill load is about 85 to 90 tons of rods, and three-in. diam rods are used as makeup charge. The feed to the rod mill is about three to five percent plus ¾-in. material. The rod mill discharge goes to the rake classifier, which overflows at 68 to 70 percent solids, to produce a very uniform product of minus eight-mesh size. This overflow product is sent to the ball mill scoop box. Coarse sands and oversize in the rod mill discharge are removed in the rake classifier and are pumped back to the rod mill feed box.

The ball mill has a load of about 50 tons of balls, and the makeup charge is 60 percent two-in. and 40 percent 1½-in. balls. The ball mill discharge is split to two duplex 54-in. spiral classifiers operating in closed circuit. The discharge pulp is about 66 to 68 per-

cent solids and the classifier overflows are maintained at 34 to 35 percent solids, to give a 28 to 30 percent plus 65 mesh feed to the flotation sections. The tonnage treated in each complete grinding circuit is between 3800 to 4000 tons per 24 hr. This gives a total 38,000 to 40,000 tons daily capacity for the ten sections of the concentrator.

Early Tests Show Improvement Possible

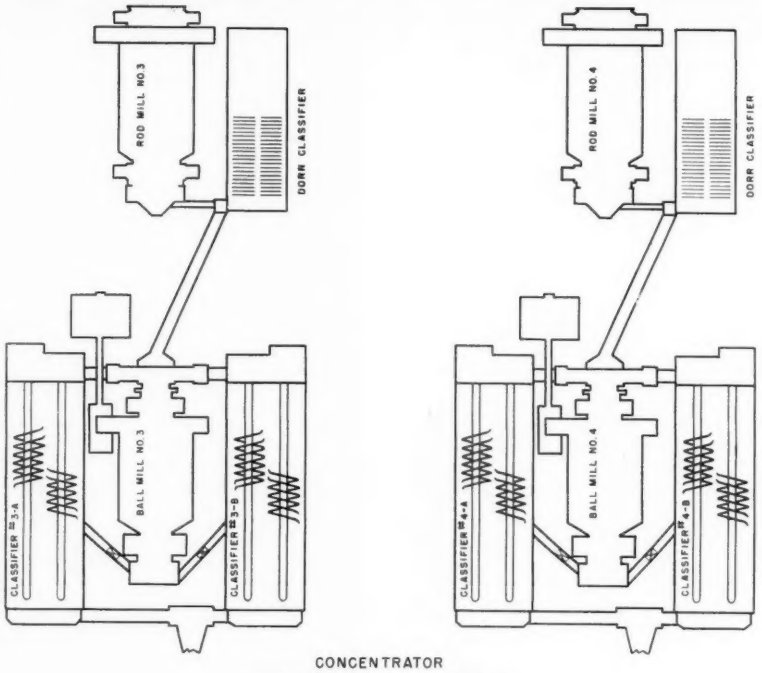
During the last few months of 1955, several tests were run in which a grinding circuit was tried using one 10 by 14-ft rod mill to feed two 10 by 12-ft ball mills. These tests gave results indicating that one rod mill could make a product—up to 4800 tons per 24 hr—which could be ground in the two ball mill and classifier circuits, to produce suitable sizes for flotation operations. These results immediately indicated that if extra ball mills were installed they could be used to divide or increase the tonnage now being treated. By dividing the rod mill load, the present tonnage now being handled, could be ground much finer and the metallurgical recoveries and grades of products benefited. By increasing the rod mill load, the total tonnage would be increased and at the same time, if the increase was not excessive, the present metallurgical work could be maintained or bettered.

The first and most vital change would be to benefit the metallurgical results with a finer grind in the feed to the flotation section. The desired grind would lower the present 28 to 30 percent plus 65 mesh product to a range of 12 to 18 percent plus 65 mesh product. To install such extra ball mills, with the regular classifier circuits in the present mill layout, would be impossible, due to the lack of vital space.

Cyclones Offer Solution to Space Problem

It was realized, however, that by replacing the present classifiers with cyclones for the classification circuit, enough space could be obtained to permit the desired extra ball mill installations to be made. The cyclones and the new ball mills would be located between the present ball mill units. The present building and the grinding circuit areas would not have to be increased.

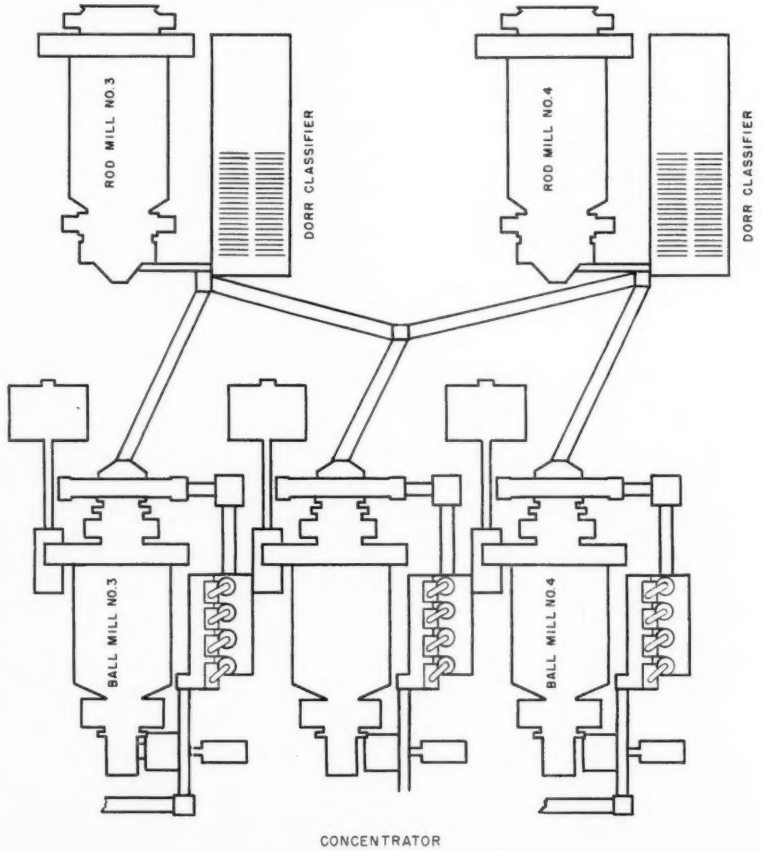
In early 1956, results obtained in cyclone classification tests at Potrerillos concentrator, and the successful use of cyclone classification in the primary grinding circuits in other concentrators, crystallized the decision of the management to install a test cyclone classification system in one of the 10 by 12-ft ball mill circuits at Chuquicamata. This temporary unit would be used to test one section of the mill, and could be operated in direct comparison with the adjoining section us-



CONCENTRATOR

EXISTING GRINDING CIRCUIT

The existing system of two rod mills and two ball mills with the duplex classifiers, and the proposed system of two rod mills and three ball mills with three cyclone classifiers, are shown schematically



CONCENTRATOR

PROPOSED GRINDING CIRCUIT

ing the regular grinding circuit, consisting of the 10 by 12-ft ball mill in closed circuit with the two duplex 54-in. spiral classifiers.

The temporary cyclone circuit was completed in early January, 1957, without interfering with the regular operations. The cyclones of the temporary setup had to be placed at a much higher elevation than desired—about twenty-seven feet above the pump. This limited, to some extent, the tonnages that could be tested. Up to the normal feeds of 3800 short tons per 24 hours, the tests were uniform and acceptable. Larger tonnages caused an increase in loading, to the extent that the pump motor and circuit overloaded and the tests were stopped. In the cyclone circuit, the ball mill discharge, at about 66 to 68 percent solids, was passed through one classifier and was delivered by launder to the pump sump. The classifier removed tramp ball and other outsize. Water was added at the pump sump to deliver a feed of about 50 to 60 percent solids to the cyclones. The cyclone overflow ranged from 32 to 45 percent solids and the underflow from about 70 to 75 percent solids. The overflow was diluted, as necessary, to give a feed to the flotation cells of about 30 percent solids. The underflow was returned by sand launder, to mix with the discharge of the rod mill grinding circuit going to the scoop box of the ball mill.

Tests Favor Use of Cyclones

Several series of tests were run under varying conditions. The main testing was made on different tonnages. Normal tonnage in the concentrator circuit is considered to be at the rate of 165 tons per hr. Tests were divided into three groups: (1) using less than the normal tonnage of feed, (2) using the normal tonnage of feed (the results of these two series are shown in tables I and II), and (3) using greater than normal tonnage of feed. In the latter tests the circuit and the pump motor very soon became overloaded and the tests were stopped.

From the favorable tests results obtained, it was decided to install one permanent cyclone classification circuit in one of the 10 by 12-ft ball mill grinding sections, to replace the regular classifier circuit. The layout was designed to allow room for the installation of an extra ball mill in the space left vacant by the removal of the two duplex classifiers of the original circuits. The first of these permanent ball mill-cyclone grinding circuits was completed in May of this year. It has been tested in comparison with the adjacent ball mill-classifier circuit with the results shown in Tables III and IV.

TABLE I

FEED BELOW NORMAL TONNAGE—Two 30-in. Cyclones in Circuit

Control Data

Pressure at cones:	7½ psi
Inlet nozzle:	34 sq in.
Vortex:	8-in. diam.
Apex:	4¼-in. diam.

Screen Analysis and Flow Data

	Feed	Cyclone Circuit Overflow	Cyclone Circuit Underflow	Classifier Circuit Overflow
GPM	2179	1234	945	
% Solids	55.7	36.6	72.4	35.0
Dry Short Tons/Hr	468	147	321	147
Mesh	**% Wt**	**% Wt**	**% Wt**	**% Wt.**
Plus 65	59.9	24.4	76.0	28.3
Plus 200	18.6	28.2	14.5	28.2
Minus 200	21.5	47.4	9.5	43.5
Circulating Load in Ball Mill Circuit		220%		170%
Total Copper Assays				
Total Feed		1.27%		1.32%
Plus 65 Mesh Fraction		0.38%		0.76%
Copper Distribution				
Plus 65 Mesh		7.3%		16.3%
Plus 200 Mesh		24.9%		29.9%
Minus 200 Mesh		67.8%		53.8%
Total Tailings				
% Total Copper		0.23		0.26

TEST RESULTS: Feed was under normal tonnage—147 short tons per hour. The cyclone circuit overflow reported lower percent weight and lower copper content in the plus 65 mesh sizes. It also showed better copper distribution in the screen sizes and a lower total tailings assay in the flotation circuit. All of these items would favor the cyclone circuit.

TABLE II

FEED AT NORMAL TONNAGE—Four 20-in. Cyclones in Circuit

Control Data

Pressure at cones:	4½ psi
Inlet nozzle:	21 sq in.
Vortex:	7½-in. diam.
Apex:	3½-in. diam.

Screen Analysis and Flow Data

	Feed	Cyclone Circuit Overflow	Cyclone Circuit Underflow	Classifier Circuit Overflow
GPM	2105	1005	1100	
% Solids	63.0	46.4	74.7	34.5
Dry Short Tons/Hr	571	165	396	165
Mesh	**% Wt**	**% Wt**	**% Wt**	**% Wt.**
Plus 65	63.2	30.2	77.0	31.6
Plus 200	16.8	28.6	12.2	27.8
Minus 200	20.0	41.2	10.8	40.6
Circulating Load in Ball Mill Circuit		240%		155%
Total Copper Assays				
Total Feed		1.31%		1.31%
Plus 65 Mesh Fraction		0.47%		0.72%
Copper Distribution				
Plus 65 Mesh		10.1%		17.6%
Plus 200 Mesh		28.3%		29.7%
Minus 200 Mesh		61.6%		52.7%
Total Tailings				
% Total Copper		0.23		0.24

TEST RESULTS: Normal feed tonnage: 165 short tons per hour. The cyclone circuit overflow reported equal percent weight in the plus 65 mesh. Also equal tailings assay in the flotation circuit. It reported lower copper assay in the plus 65 mesh and lower copper content in the plus 65 mesh fraction of the distribution. The results favor the cyclone circuit.

Expect 20 Percent Gain in Grinding Capacity in Same Space

The favorable results obtained in the use of cyclone classification in the No. 3 section ball mill grinding circuit have made possible immediate plans for increasing the capacity of the present concentrator, by installing extra ball mill grinding circuits in conjunction with the present rod mill grinding circuits. The first change will be to install one extra ball mill between the ball mills in sections No. 3 and 4. This will make a new grinding unit consisting of two rod mills and three ball mills. In this new unit, the discharge of the two 10 by 14-ft rod mills will be split between the three ball mill scoop boxes. Each of the three 10 by 12-ft ball mills will be in closed circuit with a cyclone classification system. The overflows from the three cyclone systems will be split to feed two flotation systems and the operations will be normal from there on out.

The present system of two rod mills and two ball mills with the duplex classifiers, and the proposed system of two rod mills and three ball mills with three cyclone classifiers, are shown schematically above.

In the proposed two rod mill, three ball mill units, the first testing would start in the present tonnages of about 4,000 tons per rod mill or 8,000 tons per grinding unit. With the 8,000 tons split between the three ball mills it is expected a 12 percent plus 65 mesh product will be produced in the cyclone overflows. When conditions have been standardized and the entire grinding unit and the flotation sections are operating smoothly, the

TABLE III

FEED AT NORMAL TONNAGE—Four 20-in. Cyclones in Circuit

Control Data			
	Pressure at cones:		4¾ psi
	Inlet nozzle:		21 sq in.
	Vortex:		7½-in. diam.
	Apex:		3¼-in. diam.

Screen Analysis and Flow Data

	Feed	Cyclone Circuit Overflow	Cyclone Circuit Underflow	Classifier Circuit Overflow
GPM	2947	1250	1697	
% Solids	61.3	40.3	72.8	35.4
Dry Short Tons/Hr	720	166	554	163
Mesh	**% Wt**	**% Wt**	**% Wt**	**% Wt.**
Plus 65	63.0	27.0	73.9	31.0
Plus 200	18.8	27.4	16.1	27.2
Minus 200	18.2	45.6	10.0	42.8
Circulating Load in Ball Mill Circuit			330%	170%
Total Copper Assays				
Total Feed			1.31%	1.30%
Plus 65 Mesh Fraction			0.47	0.66
Copper Distribution				
Plus 65 Mesh			9.7%	17.3%
Plus 200 Mesh			23.4%	25.3%
Minus 200 Mesh			66.9%	57.4%
Total Tailings				
% Total Copper Assay			0.27	0.32

TEST RESULTS: Normal feed tonnage: 165 short tons per hour. The cyclone circuit reports lower copper assay, percent weight, copper distribution and in the plus 65 mesh size. It also shows better copper distribution in the other screen sizes and a lower copper assay in the flotation circuit tailings. All of these results favor the cyclone circuit classification.

tonnages will be increased to a point which is still within desired metallurgical and operating range. This new tonnage is expected to vary between 4500 to 4700 tons per 24 hr per rod mill or 45,000 to 47,000 short tons for the entire plant of ten sections. The final installation will have ten rod mills and fifteen ball mills in place of the present ten rod mills and ten ball mills. All of the present spiral classifier circuits would be replaced with cyclone classifier circuits.

The extra flotation capacity needed to handle increased tonnage does not present the same problem as the grinding circuits. When the concentrator was designed, the engineers provided space for an increase of 33 percent in flotation cell capacity. New cells have been installed in this space and are treating the present 40,000 tons per day of feed. No change would have to be made to handle an increase of up to 10,000 tons per day to the flotation circuits. Above that tonnage some extra capacity would be needed. The results of the cyclone work in the concentrate cleaner and regrind sections might help provide the extra needed capacity for the flotation sections, by making part of the present cleaner flotation cells available for the rougher flotation circuits.

Scouring Action Improves Flotation

Testing the cyclone classifiers in the concentrate regrind circuit has produced some very interesting, as well as improved, results. In this case the capacity changes have been secondary to the benefits obtained from improved sharpness of cut in the classification of the particle sizes, and the possible cleaning and scouring effect from the action in the cyclone itself. The cyclone does not grind the minerals, but the actions in the cyclone, which make up the force pattern, could bring any coated or tarnished particles into a zone where they are subjected to some action such as pressure and shear, or both. In this zone they could be affected to the point that part, or all of the particles would be partially freed of any tarnish or coating and become amenable to separation in subsequent ball mill grinding or flotation actions.

Chuquicamata sulphide ores from the open-pit sections have considerable amounts of pyrite particles with very thin chalcocite coatings and tarnished chalcocite coatings. In regular flotation operations, the coated or tarnished pyrite particles are floated as copper minerals and the resultant copper concentrates have high iron content with lower copper values. The chalcocite coatings can be broken up and liberated to some extent by finer grinding action in the ball mills. The chalcocite tarnish is almost impossible to liberate by regular grinding because it covers all sides of the pyrite particle. These chalcocite tarnish coatings are in the range of 0.01 to 1.0 micron. The chalcocite mineral coatings are in the range of 2 to 50 microns. In the present regrind circuits, the tarnished and coated pyrite particles do not seem to be sufficiently changed by the regular grinding action, to make acceptable grades of concentrates. In the cyclone classifications test circuit, the action of the cyclone, together with the increased circulating loads through the ball mill and the extra sharpness of the cut in the classification of the particle size, all seem to combine to liberate more free particles of pyrite. These free pyrite particles are separated and higher copper concentrate grades are the result.

All of the statements as to actions in the cyclone and the effects on the mineral particles being treated are opinions based on observations, not proven facts. In the tests made, the results described above were obtained. However, it is not known exactly what happened in the cyclone to benefit the flotation conditions, but the results were evident.

In the present ball mill-classifier regrind circuit, the classifier overflow at 20 percent solids will have about 10 percent of plus 200 mesh sizes by weight. In the cyclone-ball mill regrind circuit, the cyclone at 20 percent solids will have about seven percent of 200 mesh sizes. When the two circuits have the same 10 percent of 200 mesh sizes in the overflows, the classifier overflow will have 20 percent solids and the cyclone overflow will have 27 percent solids. In both cases the concentrates produced in the flotation circuits will show higher grades from the cyclone classification circuits.

(Continued on page 72)

TABLE IV

SAME PERCENT OF 65 MESH IN BOTH CIRCUIT OVERFLOWS—Four 20-in. Cyclones

Control Data			
	Pressure at cones:		5¼ psi
	Inlet nozzle:		21 sq in.
	Vortex:		7½-in. diam.
	Apex:		3½-in. diam.

Screen Analysis and Flow Data

	Feed	Cyclone Circuit Overflow	Cyclone Circuit Underflow	Classifier Circuit Overflow
GPM	2488	1135	1353	
% Solids	61.9	44.3	72.6	32.7
Dry Short Tons/Hr	648	175	473	164
Mesh	**% Wt**	**% Wt**	**% Wt**	**% Wt.**
Plus 65	61.7	30.4	73.0	30.6
Plus 200	17.6	27.8	14.2	25.7
Minus 200	20.7	41.8	12.8	43.7
Circulating Load in Ball Mill Circuit			270%	170%
Total Copper Assays				
Total Feed			1.35%	1.37%
Plus 65 Mesh Fraction			0.51%	0.76%
Copper Distribution				
Plus 65 Mesh			11.5%	15.8%
Plus 200 Mesh			29.3%	23.7%
Minus 200 Mesh			59.3%	60.5%
Total Tailings				
% Total Copper Assay			0.28	0.31

TEST RESULTS: When the two circuits are operated to deliver the same percent of plus 65 mesh sizes in the overflows, the cyclone will treat higher tonnages, with better distribution of copper in the screen sizes, and lower tailings in the flotation circuit. All factors favor the cyclone circuit.

1958 AMC COAL CONVENTION

Industry makes plans for a most important meeting

WITH the dates of the 1958 Coal Convention of the American Mining Congress rapidly approaching, coal mine operators are making plans to attend and participate in one of the most important meetings they have held in many years. Highlighted by the scheduled appearance of UMWA president John L. Lewis, who will address a special luncheon Monday, May 5, the three-day meeting offers a rich "bill of fare" for the coal industry.

Under the chairmanship of James C. Gray, administrative vice-president, raw materials, United States Steel Corp., the program committee has organized an outstanding technical program around the theme of this year's meeting—"Research for Progress." Eleven convention sessions will focus industry attention on such timely subjects as the status of coal research, mine safety, coal preparations, continuous and conventional mining, strip mining, etc., with eminent speakers from within and without the coal industry addressing the meeting. Discussion from the floor will be invited so that the greatest possible benefit may be gained from each paper. The program marks the culmination of the year's work of the Coal Division of the American Mining Congress, under the leadership of L. C. Campbell.

In addition to John L. Lewis, a feature attraction at the special luncheon Monday, May 5, will be the appearance of George M. Humphrey, chairman of National Steel Corp. and former Secretary of the Treasury, who will introduce Mr. Lewis. At Tuesday's luncheon Bob Feller, the famous American League baseball pitching great, will offer a change of pace with a discussion of the player's side of our national pastime.

Much effort has also gone into the planning of evening entertainment functions. On Monday night the traditional Coal Miners Party will be held at Cincinnati's famous Castle Farm. No stone is being left unturned to assure another outstanding affair in the tradition of previous Coal Miners Parties. The convention will be climaxed Wednesday evening with a "speechless" banquet, with brief introductions of honor guests and a sparkling program of "name" entertainment.

A particularly inviting series of daytime events has been arranged to occupy the ladies while their men are busy at the various meetings during the day.

All who are planning to attend the 1958 Coal Convention are urged to make room reservations promptly with any of Cincinnati's hotels and to send in the advance registration card recently distributed to the industry.

PRELIMINARY PROGRAM

MONDAY • MAY 5

10:00 A.M.—Research for Progress

Chairman—JAMES C. GRAY,
Administrative Vice-President—Raw Materials, U. S. Steel Corp., Pittsburgh, Pa.,
and *Chairman*, National Program Committee

The Human Side of Research

A most important part of all research is human attitude. Dr. Alexander will highlight the advantages—the real need in fact—of a deep personal interest in research.

DR. W. H. ALEXANDER, *Pastor*, The First Christian Church, Oklahoma City, Okla.

Research in the Coal Industry

Following an appraisal of coal research in this country and in the major coal-producing areas of Europe, Dr. Potter will report on new findings in the United States through coal research, and on the utilization of laboratory results for the benefit of coal users.

DR. A. A. POTTER, *President*, Bituminous Coal Research, Inc., Lafayette, Ind.

12:15 P.M.—Luncheon Address

Guest Speaker—JOHN L. LEWIS
President, United Mine Workers of America

MR. LEWIS will be introduced by
GEORGE M. HUMPHREY, *Chairman*, National Steel Corp.

2:15 P.M.—Strip Mining

Chairman—R. J. HEPBURN, *Vice-President*,
The United Electric Coal Companies, Chicago, Ill.

Two Seam Stripping and Parting Removal

A specially designed 55-cu yd shovel has simplified the job of strip mining two seams of coal at Peabody Coal Company's River Queen mine in western Kentucky.

FRANK GILBERT, *Superintendent*, River Queen Mine, Peabody Coal Co., Greenville, Ky.

Current Practices in Anthracite Stripping

New equipment and techniques never allow technology to stand still. Here is a review of the latest advances in stripping anthracite.

A. E. CODDINGTON, *Vice-President*, Carey, Baxter, & Kennedy, Inc., Mahanoy City, Pa.

Discussion—JAMES R. BAZLEY, *Vice-President*, J. Robert Bazley, Inc., Pottsville, Pa.

(Continued on next page)

(Continued from previous page)

Developments in Ammonium Nitrate Blasting

A major breakthrough in strip mine blasting, the use of ammonium nitrate as an explosive continues to excite great interest. Innovations in the use of this explosive will be discussed.

ROBERT AKRE, *Superintendent of Drilling & Blasting*, The Maumee Collieries Co., Terre Haute, Ind.

2:15 P.M.—Underground Power

Chairman—GEORGE L. JUDY, *Vice-President*, Consolidation Coal Co. (W. Va.) Division of Pittsburgh Consolidation Coal Co., Fairmont, W. Va.

Factors in Evaluating and Selecting A-C Power Systems for Underground Coal Mining

What are the major considerations in choosing an a-c power system for underground application? Mr. Huffman's paper has been designed to answer this important problem facing mining men today.

C. R. HUFFMAN, *Staff Electrical Consultant*, Donegan Coal & Coke Co., Richwood, W. Va.

Discussion—DAVID E. HAMILTON, *Application Engineer-Mining*, General Electric Co., Schenectady, N. Y.

Selection of A-C Distribution Equipment

Factors that determine the selection of distribution equipment for an a-c power system from the drill hole up to and including the junction box and trailing cables will be discussed.

JOHN A. STACHURA, *General Superintendent*, Enoco Collieries, Bruceville, Ind.

Operating Experience with A-C Mining Equipment

How do the theoretical advantages of a-c power stand up in actual practice? Here is a report on that subject from a company which has had several years of experience with both continuous and conventional a-c mining equipment.

S. H. SHERRARD, JR., *Chief Engineer*, and ANDREW RUSNAK, *Maintenance Supervisor*, Johnstown Coal & Coke Co., Portage, Pa.

Coal Miners Party
Cincinnati's Famous Castle Farm

Cocktail hour begins at 6:30 P.M., followed by dinner, dancing and entertainment.

TUESDAY • MAY 6

9:30 A.M.—Coal Preparation

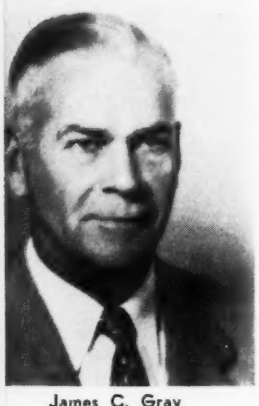
Chairman—WILMOT C. JONES, *Vice-President*, Jeddo-Highland Coal Co., Jeddo, Pa.

Fine Coal Preparation at Crucible Steel

The removal of fines through froth flotation and filtration has improved the efficiency of Crucible Steel's fine coal preparation plant.

M. C. CHANG, *Research Department*, Crucible Steel Company of America, Pittsburgh, Pa.

PROGRAM COMMITTEE—MEMBERS



James C. Gray
Administrative Vice-President—Raw Materials, U.S. Steel Corp.
National Chairman

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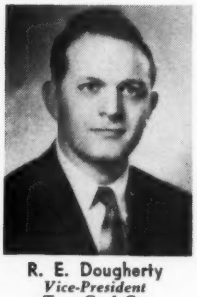


R. E. Dougherty
Vice-President
Tasa Coal Co.

Oscar A. Glaeser
President
United States Fuel Co.

Benefits of Reducing Circulating Solids

Here is the story of what happened at the Vesta-Shannopin coal preparation plant of Jones & Laughlin Steel Corp. when management set out to reduce the circulating solids load. Operators of this coal cleaning plant which is one of the world's largest are true converts, and would wash coal with clear water if they could.

J. J. REILLY, *Coal Preparation Superintendent*, Vesta-Shannopin Preparation Plant, Jones & Laughlin Steel Corp., California, Pa.

Pumping Coal and Refuse

This paper will concentrate on the use of solids handling pumps for the transportation of coal and refuse in and about coal preparation plants. Special attention will be paid to multiple staging of pumps for high heads and to general problems encountered in the design of pumps and pipe lines.

PAUL LEVIN, *Project Engineer*, Allen & Garcia Co., Chicago, Ill.

Recent Advances in Coal Thermal Drying

Manufacturers of thermal drying equipment are constantly improving their particular units. The latest refinements in equipment design and application will be discussed.

F. R. ZACHAR, *Consulting Mining Engineer*, Morgantown, W. Va.

9:30 A.M.—Safety

Chairman—RALPH E. KIRK, Consulting Engineer, Birmingham, Ala.

Mine Lighting

Mine lighting has much to offer the coal industry—but there are problems too. U. S. Steel has installed lights on one section and is studying the effects closely to assess accurately the potentialities of area lighting.

ROBERT R. GODARD, *Electrical Engineer*, U. S. Steel Corp., Uniontown, Pa.

Experience with Flame Resistant Belting

A factual account of how one company has used flame resistant belting and what its experience has been over a two-year period.

DONALD B. SHUPE, *Mine Superintendent*, Eastern Gas & Fuel Associates, Barrett, W. Va.

Safety Advantages in the Use of A-C Power Underground

In non-technical language, an electrical engineer will show how a properly engineered a-c system is safer than a d-c system, especially where large mobile machines are concerned.

RALPH M. HUNTER, *Manager*, Electrical & Mechanical Department, Rochester & Pittsburgh Coal Co., Indiana, Pa.

Rock Dusting in Multiple Shift Operations

Among the subjects covered in this paper will be rock dusting in triple shift operations utilizing off-track mechanical equipment, double shift operation utilizing mechanical equipment on track, and a double shift operation in thin coal where mobile equipment is used with belt haulage.

C. E. LINKOUS, *Director of Safety*, Island Creek Coal Co., Holden, W. Va.

12:15 P.M.—Luncheon

Presiding: JACK H. HOW, *President*, Western Machinery Co., and *Chairman*, Manufacturers Division, American Mining Congress

Address: BOB FELLER, All-Time Baseball Great

2:15 P.M.—Haulage

Chairman—W. A. GALLAGHER, *Vice-President*, Stonega Coke & Coal Co., Philadelphia, Pa.

Recent Developments in Shuttle Cars

What is the "new look" in shuttle cars, the vital link in coal's production line? This paper will describe changing equipment designs as shuttle car manufacturers move to keep pace with industry demands.

A. L. LEE, *Manager*, Lee Engineering Division, Pittsburgh Consolidation Coal Co., Columbus, Ohio

Combination Belt and Mine Car Haulage

It is doubtful if the question of rail haulage vs. conveyor haulage will ever be fully settled, but combination haulage has been the answer to the need for efficient transportation under a variety of conditions at several operations.

C. WARD PADGETT, *General Superintendent*, Southern Illinois Division, Bell & Zoller Coal Co., Zeigler, Ill.

M. H. SHUMATE, *Assistant General Manager*, Truax-Traer Coal Co., Kayford, W. Va.

Discussion—E. M. PACE, *General Superintendent*, Inland Steel Co., Wheelwright, Ky.

An Operations Research Approach to Mine Haulage

Operations research—a means of solving problems with a large number of variables—has been used with great success to answer many difficult questions of production and programming. The same approach can be used to design mine haulage systems.

ERNEST KOENIGSBERG, *Head*, Operations Research Section, Midwest Research Institute, Kansas City, Mo.

Discussion—O. D. MCDANIEL, *Manager*, Industrial Engineering, Old Ben Coal Co., West Frankfort, Ill.

(Continued on next page)

A. G. Gossard
Vice-President
Snow Hill Coal Corp.

R. A. Gray
District Manager
Rome Cable Corp.

R. L. Halstead
Manager
Processing Machinery Div.
Allis-Chalmers Mfg. Co.

C. W. Hamilton
Vice-President
Virginia Iron, Coal & Coke Co.

J. L. Hamilton
Executive Vice-President
Island Creek Coal Co.

W. D. Hamilton
Vice-President
Coal Operations
Oglebay Norton Co

H. John Harper
Vice-President
Eastern Gas & Fuel Associates

W. A. Haslam
President
Winding Gulf Coals, Inc.

C. T. Hayden
Vice-President
Sahara Coal Co.

W. E. Hess
Manager of Coal Mines
Jones & Laughlin Steel Corp.

Jack H. How
President
Western Machinery Co.

James Hyslop
President
Hanna Coal Co.

(Continued from previous page)

2:15 P.M.—Continuous Mining

Chairman—J. L. HAMILTON, *Executive Vice-President*, Island Creek Coal Co., Huntington, W. Va.

Continuous Mining In Thin Seams

First applied to thicker seams of coal, continuous mining is now being used effectively in thinner coal. Here is one company's experience in seams under 48 inches.

W. J. B. MAYO, *Division Manager*, Eastern Gas & Fuel Associates, Melcroft, Pa.

Performance Standards for Continuous Mining

An engineer from a company with nine years' experience in continuous mining will explain how equipment is rated and performance standards set.

DONALD C. HOWE, *Mining Industrial Engineer*, Vesta-Shannopin Coal Division, Jones & Laughlin Steel Corp., California, Pa.

A Report On Continuous Mining Productivity

Statistical data will be given showing productivity of mines using continuous mining equipment as compared to those using conventional equipment. This is the first authentic nationwide report on this subject ever put together.

R. L. ANDERSON, *Supervisory Commodity-Industry Analyst*, U. S. Bureau of Mines, Washington, D. C.

Maintenance of A-C Continuous Mining Equipment

Maintenance practice at this western coal company where a-c continuous mining equipment has been in service for several years will be discussed.

L. T. LINDSAY, *Shop Foreman*, Sunnyside Mine, Kaiser Steel Corp., Sunnyside, Utah

Analysis of Service Haulage Behind Continuous Mining Equipment

Not only will present practice and projections be reviewed but potential systems of materials handling such as self-propelled shuttle cars, gas turbine powered equipment and other new concepts will be covered.

GERALD VON STROH, *Director, Mining Development Committee*, Bituminous Coal Research, Inc., Huntington, W. Va.

PROGRAM COMMITTEE

Continued

WEDNESDAY • MAY 7

9:30 A.M.—Conventional Mining

Chairman—OSCAR A. GLAESER, *President*, United States Fuel Co., Salt Lake City, Utah

High Production In Thin Seams

Small crews are achieving high production in 38 to 42-inch coal using rubber-tired top-cutting machines, a new mine projection and bridge conveyors at the Tioga Coal Corp.

J. L. MCQUADE, *President*, Tioga Coal Corp., Tioga, W. Va.

Foreman Training

Subjects to be discussed include ways in which a foreman training program can be set up, the benefits that can be expected from such a program and how it compares to a full-fledged industrial engineering program.

JOHN E. KAITES, *Industrial Engineer*, Berwind-White Coal Mining Co., Windber, Pa.

Preventive Maintenance

Methods of preventive maintenance—from substations, haulage equipment and stationary motors to face equipment, rebuilding and mechanic training—as they are practiced at the Elk River Coal & Lumber Co. will be described.

JOHN L. HENLEY, *Master Mechanic & Chief Electrician*, Elk River Coal & Lumber Co., Widen, W. Va.

Modern Approach to Equipment Maintenance

Before an effective maintenance program can be designed a philosophy of maintenance has to be decided upon. This paper deals with the importance of such an approach, outlining many of the concepts that have special impact on the final maintenance program.

RALPH B. DEAN, *Administrative Assistant*, Lorado Coal Mining Co., Columbus, Ohio

9:30 A.M.—Coal Preparation

Chairman—R. H. HUGHES, *President*, Clinchfield Coal Co., Dante, Va.

Reducing Coal Preparation Costs Through Automation

Labor required to handle railroad cars at Peabody Coal Company's River King and River Queen mines has been

R. D. Ketner
Manager, Mining and Nonferrous Industries Sales
General Electric Co.

Ralph E. Kirk
Consulting Engineer
Birmingham, Ala.

Harry LaViers
President
South-East Co., Inc.

C. E. Lawall
Vice-President
Chesapeake & Ohio Railway Co.

Frank Lehecka
Assistant to Manager
Specialty Products
U. S. Steel Corp.

L. E. MacDonald
General Sales Manager
Bucyrus-Erie Co.

E. R. Phelps
Vice-President
Pittsburg & Midway Coal Mining Co.

L. A. Price
Manager, Eastern Div.
Union Wire Rope Corp.

Davis Read
Consulting Engineer
Sturgis, Ky.

Carel Robinson
Consulting Engineer
Charleston, W. Va.

J. H. Sanford
Manager, Mining Div.
Ohio Brass Co.

W. C. Schott
Vice-President
Stonega Coke & Coal Co.

reduced from six men to one man through automation of the tipple car hauls.

GEORGE H. MORRIS, *Preparation Engineer*, Indiana Division, Peabody Coal Co., Boonville, Ind.

Advances in the Art of Dense Media Cleaning

Dense media cleaning has been brought within the reach of all coal operators, large or small. Here is a rundown on the newest techniques in using this method of coal preparation.

EMERY MILLIGAN, *Preparation Manager*, Freeman Coal Mining Corp., Marion, Ill.

A Prediction of Future Demands by the Electric Utility Industry in Coal Quality

What kind of quality is coal's largest user going to demand in the years to come? One of the men responsible for designing tomorrow's generating stations takes a look into the future and makes his prediction.

R. H. WOLIN, *Assistant Chief Engineer*, Combustion Engineering Co., Inc., New York, N. Y.

Research on the Nuclear Irradiation of Coal for Use with Diesel Fuel

To large users of diesel fuel the possibility of mixing finely pulverized coal with diesel oil is attractive because it would reduce fuel costs by a sizeable amount. Much research is being expended with this ultimate goal in sight, which would mean of course that part of today's railroad fuel market would be returned to coal.

RAY MCBRIAN, *Director of Research*, The Denver & Rio Grande Western Railroad Co., Denver, Colo.

2:00 P.M.—Continuous Mining

Chairman—P. P. FERRETTI, *Vice-President*, Pocahontas Fuel Co., Inc., Pocahontas, Va.

Ventilation Problems in Connection with Continuous Mining Systems

Results of tests to determine the effectiveness of a small blower operated by hydraulic pressure and incorporated as a part of a continuous mining machine will be described for the first time. Relative advantages and disadvantages of common auxiliary fan ventilation will also be discussed.

DONALD S. KINGERY, *Chief*, Mine Ventilation Section, U. S. Bureau of Mines, Pittsburgh, Pa.

Roof Support with Continuous Mining

A detailed account of what continuous mining has meant insofar as roof control is concerned at the Maxine mine of Alabama By-Products Corp., Maxine, Ala.

G. C. DYAR, *General Superintendent of Mines*, Alabama By-Products Corp., Birmingham, Ala.

Designing Continuous Mining Systems

A discussion of the problems encountered in designing a mining system to most efficiently use the full production potential of a continuous mining machine and at the same time stay within the limits of recognized good mining practice.

JESSE F. CORE, *Vice-President—Operations—Coal*, U. S. Steel Corp., Pittsburgh, Pa.

Russian Developments in Continuous Mining Equipment Design

Don't sell the Russians short. They have shown remarkable ingenuity in designing some of their continuous mining units. Here is an evaluation of their equipment by an engineer who is well qualified to appraise their potential.

C. M. MCWHORTER, *Mining Engineer*, Goodman Manufacturing Co., Chicago, Ill.

Discussion—T. REED SCOLLON, *Chief*, Division of Bituminous Coal, U. S. Bureau of Mines, Washington, D. C.

2:00 P.M.—Strip Mining

Chairman—S. F. SHERWOOD, *President* Stonefort Corp., Indianapolis, Ind.

Continuous Mining in Strip Highwalls

The Powhatan Mining Co. has pioneered in the use of continuous mining equipment to recover coal left in highwalls following stripping operations. In developing the mining method that will be described, this eastern Ohio coal producer met natural conditions that caused drastic changes in the mining plan and in the type of equipment used.

A. D. HENRY, *General Superintendent*, The Powhatan Mining Co., Bloomingdale, Ohio

Developments in Strip Mine Haulage (A Symposium)

Users of the most recently introduced haulage trucks will discuss what is new with their particular piece of equipment and how it operates under field conditions.

ROBERT BUNCH, *Partner*, Bunch Construction Co., Sharples, W. Va.
WILLIAM C. LAIDLAW, *Production Engineer*, The Enos Coal Mining Co., Oakland City, Ind.
ERNEST W. BRUNS, *President*, Bolt Mining Co., Beckley, W. Va.
LOWELL E. COPELAND, *President*, Beckley Coal & Coke Co., Richwood, W. Va.
MARTIN R. HECKARD, *Superintendent*, Rapatel Operations, Midland Electric Coal Corp., Canton, Ill.

7:00 P.M.—Annual Banquet

Brief introductions of honor guests, followed by an outstanding entertainment program.

Gordon MacVean
President
National Mine Service Co.

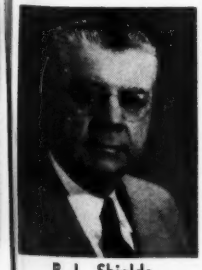
F. J. Monaghan
Explosives Div.
Olin Mathieson Chemical Corp.

W. H. Moore
Gen. Supt. of Mines
Susquehanna Collieries

C. R. Nailler
President
Christopher Coal Co.

H. H. Pancake
Manager, Mine Car Miscellaneous Sales
ACF Industries, Inc.

R. G. Pfahler
Mining Engineer
Berwind-White Coal Mining Co.



P. L. Shields
President
Spring Canyon Coal Co.

Bradley Sparks
General Manager
W. G. Duncan Coal Co.

R. H. Swallow
Vice-President
Ayrshire Collieries Corp.

E. B. Winning
Assistant Vice-President
Republic Steel Corp.

Harold A. Zell
Manager, Mining Sales
Firth Sterling, Inc.

Photos Not Available

Harry F. Lawrence
Assistant Vice-President
W. S. Tyler Co.

E. Morgan Massey
President
Gay Mining Co.

A NEW APPROACH

To Conventional Coal Mining Problems

"Queue Theory," an analytical technique utilized by Operations Research, has been successfully used in a preliminary analysis of mechanized underground coal operations. By representing the deep-mining operation in terms of a mathematical model, operating characteristics such as output and machine delays can be predicted to a reasonably high degree of accuracy. Not only are the results of the study promising, but they suggest other profitable areas for the future concentration of research efforts in the mining industry

By ERNEST KOENIGSBERG
Head, Operations Research Section
and
SUSAN R. NEUBERGER
Both of Midwest Research Institute

METHODS which were once used only in the fundamental sciences are today being applied more and more to problems arising in day-to-day industrial and commercial operations. This relatively new technique, now called Operations Research, makes use of many different scientific tools, several of which can be applied to mining. In particular, that known as "Queue Theory" has recently been used successfully in a preliminary analysis of conventional mechanized deep-mining operations in the coal industry.

The study was carried out by representing the deep-mining operation in terms of a mathematical model. The use of models to demonstrate the characteristics of mining equipment and operations is, of course, not new; models have always been a convenient way to illustrate principles or methods because they often do away with the need for expensive and time-consuming on-the-job experiments. Until quite recently, however, models were generally physical reproductions, on a convenient scale, of the equipment or operation being studied. The models used in Operations Research are often different, being of the analogue and mathematical-statistical types, and this analysis provides a good illustration of the way they are applied. A rather unusual concept was used to devise a mathematical model that would describe the actual operation being studied, but the close agreement between results finally calculated and those obtained in practice showed that the approach was justified. Such operating characteristics as output and machine delays could be predicted to a reasonably high degree of accuracy.

Essentially, the mining process is one in which a section, consisting of a group of specialized machines and their complement of personnel, works on a number of faces in succession. The functions of these machines are carried out in a cyclic pattern; for example, at Mine No. 22 of the Old Ben Coal Corp., Benton, Ill., a face is worked in sequence by a cutting machine, a drilling machine, a blasting crew, a loading machine group (one loader and one or more shuttle-buggies) and a timbering or roof-bolting machine. Each machine moves to the next face when it has completed its task. In using "Queue Theory" to provide a mathematical model of this system, advantage is taken of the fact that the work time for a particular operation is not constant but is subject to some random variation about a mean value. Fig. 1 illustrates, for example, how the cutting time in a particular mine (data obtained from one section of Mine No. 22) can vary. Since all the machines show this type of work-time pattern and no machine can move to the next face until it is no longer occupied by the previous machine, all the operations carried out in this cyclic order are subject to random delays.

The problem then reduces to the determination of the probability that a machine can move freely to the next operation and perform its task there without interference. Even if all the machines were to work at the same mean rate (the state of affairs known as a "balanced system"), the random variations in service times still lead to the delaying of some machines between faces while the preceding machines complete their jobs. Such waiting time is certainly unprofitable from the point of view of coal-winning, and

E. Koenigsberg

S. Neuberger

As head of the Operations Research Section, Midwest Research Institute, Ernest Koenigsberg supervises and directs activities of the Operations Research staff and works with other groups in statistical analysis and design of experiments. Prior to his present position, he served as group leader, Special Studies Group, EMI Engineering Development Ltd., Hayes, Middlesex, England; senior project analyst, Midwest Research Institute, and associate physicist, Ames Laboratory, AEC. He is also the author of many technical articles.

Susan R. Neuberger, Fulbright Scholar and Smith-Mundt Fellow, has held positions in Great Britain in the I.C.I. Ltd., Plastics Division, and the Research Laboratories of the General Electric Company Ltd. of England. Publications include accounts of crystal-growing, scientific information work and readability studies.

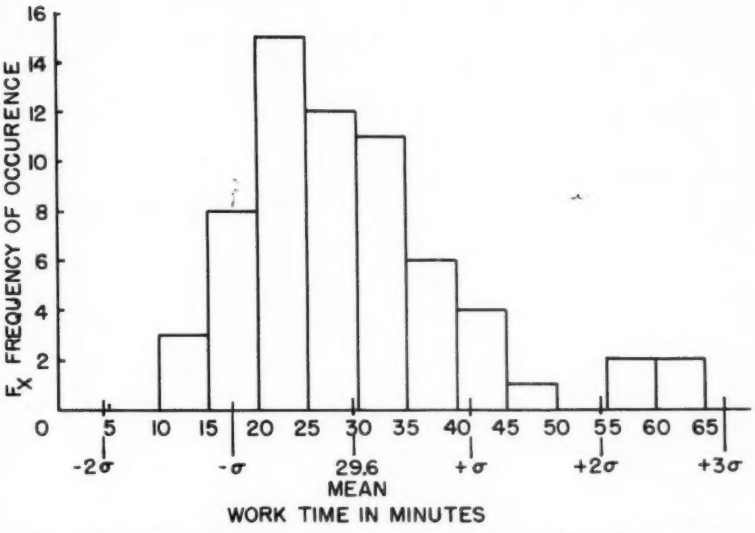


Fig. 1—Distribution of cutting time in a typical mine, showing the random variation about a mean value

the model is used to show how the delays of all machines, taken as one production unit, can be minimized so that the maximum output will be obtained. It may, of course, happen that the answer produced by the analysis cannot be put into practice, but it should nevertheless be sought. Some compromise may later be reached between the ideal theoretical solution and the limitations set in practice by such factors as cost, safety, personnel, etc.

As already outlined, in physical terms the coal-mining operation consists of a number of machines, M, which are queueing up in a fixed order to service N faces, also in a fixed order. Actually, the faces present themselves to the machines in a cycle, as illustrated in fig. 2, because a machine that has completed its task on face N returns to face 1 and repeats its cycle of operations. This cyclic pattern led to a consideration of the problem in terms which are actually the reverse of the physical ones and, in the mathematical model used, the M machines are regarded as fixed with a closed loop of N customers (faces) lining up for service at each machine in turn in a "first-come-first-served" order. Fig. 3 shows how the model describes the state of affairs illustrated in fig. 2. The time needed by a particular machine to "service" each customer or face is, as already stated, subject to some random distribution and is taken to include breakdowns and transit times. On completing service at the Mth machine the customer or face rejoins the queue at machine 1. Since the queue of faces is cyclic, it can be considered as beginning at any stage and ending at the stage immediately preceding that chosen as the first.

Results Obtained from the Analysis

The detailed mathematical treatment of this model is published elsewhere and only the more important results and the discussion will be given here. The model can be used to obtain many essential operating parameters of the conventional mechanized deep-mining process, including:

a) **The output of the system (θ)**

b) **The mean cycle time to complete service at all M stages (T)**

c) **The utilization factor of each equipment unit (U_1, U_2 . . . U_M) and of the whole production unit (U)**

The effects of modifications to the equipment can also be studied theoretically, so that the most efficient

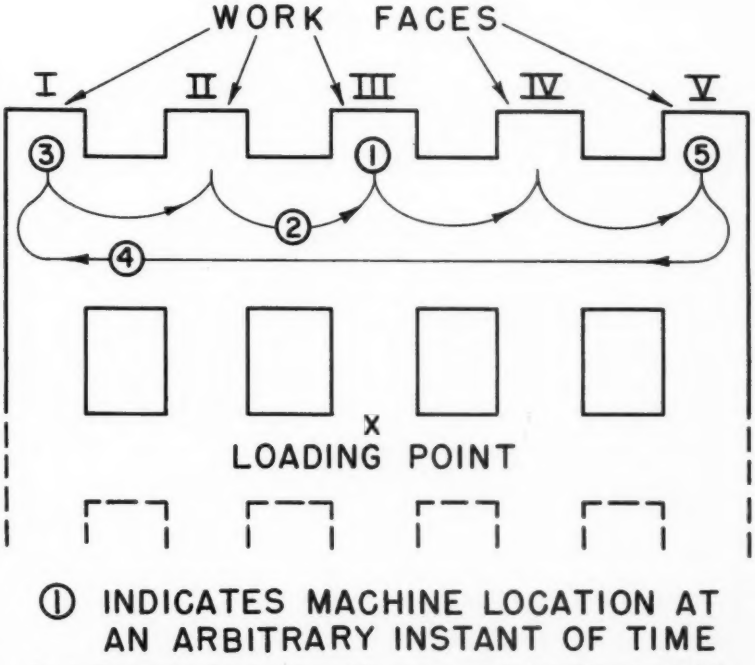


Fig. 2—The position of each mining machine at a certain instant of time in a typical mechanized deep-mining operation in which five faces are being worked by five machines

practical projection can be achieved.

Taking, first, the case of *balanced machines*, the formulae obtained for the more important quantities are:

$$T = \frac{1}{\mu}\left(M + \frac{N(N-1)}{(N+M-1)}\right) \text{ and}$$

$$\theta = H\left(\frac{N}{(N+M-1)}\right)\mu \text{ or } HU\mu \text{ where}$$

μ = the mean service time for each stage (because the machines are balanced in this case, $\mu 1 = \mu 2 = \cdots \mu M = \mu$)

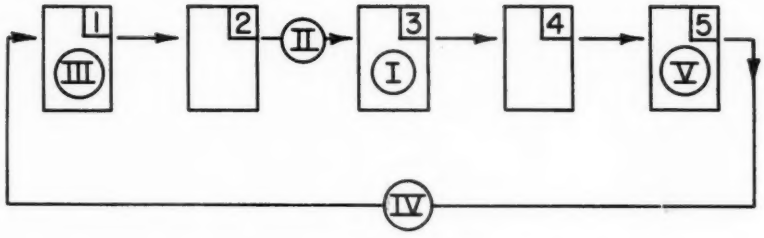
H = number of work hours per day or per shift, depending on the output figure required

U = the utilization factor of the system, defined as the ratio of working time to total process time.

Some numerical values for these and other quantities are given in table I. It is quite obvious that, for any one value of M, the utilization factor increases with the number of faces being worked. There are often, however, practical limitations to increasing N, which will be discussed later. w, the mean length of the waiting line, can be an important factor if space is at a premium, as is often the case when N is small, although N is usually greater than M in conventional mining. Since the equation for θ given above shows that output is directly related to the utilization factor, the table can be used to select a combination of M and N (wherever such a choice is possible) that gives the highest value of U.

Where the *general case* is concerned, i.e., all the machines have different service times, it is still possible to solve the equations derived from the model. As an illustration, practical operating data (collected at the Deerfield mine of the Pocahontas Fuel Corp., Pocahontas, Va.) have been used in the calculations to obtain theoretical values of the outputs for different values of N. A 58-in. seam of metallurgical coal is mined, the section under study working six faces in four stages (cutting and drilling are a single operation). Each face is cut 18 ft wide by 8.0 ft deep by 4.8 ft high, and the average cut is 28.8 tons. Table II lists the standard times, service rates and utilization factors of each stage for five, six, and seven-face operation. In practice, N = 6 and the actual output is 48.5 tph, showing the validity of the calculations which arrived at a figure of 49.0 tph.

Another illustration is based on data obtained from a section of Mine No. 22 of the Old Ben Coal Corp. where a 7-12 ft seam of Illinois No. 6 coal is worked. The section used for the analysis works six faces of a 100-in. seam in five stages (considerably more drilling is required than at



(II) INDICATES POSITION OF FACES AT SAME INSTANT OF TIME

Fig. 3—Representation, in terms of the mathematical model, of the state of affairs illustrated in figure 2

TABLE I

RESULTS FOR THREE TO SIX-MACHINE SYSTEM FOR VARIOUS NUMBERS OF CUSTOMERS (FACES)

Legend:

N = Number of faces in system
n = Mean number of faces at each stage (waiting or being serviced)
w = Mean number of faces waiting at each stage
T = Time for a face to complete M stages
U = Utilization factor (fraction of time each stage is operating)
S = Average number of customers being served in the system
M = Number of machines
D = Fraction of time a machine is down

N	n	w	T	U = 1—D	S
			M = 3		
3	1	0.4	4.2	0.6	1.8
4	1.33	0.67	5.0	0.67	2.0
5	1.67	0.95	5.85	0.71	2.13
6	2.00	1.25	6.75	0.75	2.25
11	3.67	2.83	11.49	0.85	2.55
16	5.33	4.45	16.35	0.89	2.67
21	7.00	6.09	21.20	0.91	2.73
			M = 4		
3	0.75	0.25	5.0	0.5	2.00
4	1.0	0.43	5.72	0.571	2.28
5	1.25	0.625	6.50	0.625	2.50
6	1.50	0.83	7.32	0.67	2.66
10	2.50	1.73	10.92	0.77	3.08
11	2.75	1.97	11.88	0.787	3.13
15	3.75	2.91	15.64	0.835	3.34
16	4.00	3.15	16.60	0.845	3.38
20	5.00	4.11	20.44	0.870	3.48
21	5.25	4.37	21.48	0.875	3.50
			M = 5		
3	0.6	0.17	5.85	0.43	2.15
4	0.8	0.30	6.50	0.50	2.50
5	1.0	0.445	7.22	0.555	2.775
6	1.2	0.60	8.00	0.60	3.00
9	1.8	1.10	10.50	0.70	3.50
10	2.0	1.28	11.40	0.72	3.60
11	2 2	1.47	12.35	0.73	3.65
15	3.0	2.21	16.05	0.79	3.95
16	3.2	2.40	17.00	0.80	4.00
20	4.0	3.16	20.80	0.84	4.20
21	4.2	3.36	21.80	0.84+	
			M = 6		
3	0.5	0.125	6.75	0.375	2.25
4	0.667	0.223	7.34	0.444	2.66
5	0.833	0.333	8.00	0.500	3.00
6	1.0	0.455	8.73	0.545	3.27
10	1.667	1.00	12.00	0.67	4.00
11	1.833	1.146	12.86	0.687	4.12
15	2.50	1.750	16.50	0.750	4.50
16	2.667	1.905	17.45	0.762	4.57
20	3.333	2.533	21.20	0.800	4.80
21	3.500	2.692	22.10	0.808	4.85

Deerfield) and the average cut is about 50 tons. Table III gives the calculated results for six, seven and nine-face operations. Once again, the agreement between the theoretical result (77.25 tph) and the actual output (80.0 tph) is close enough to show the success of the model used.

It is possible to have a situation in which the mean service times of all the machines are neither the same nor all different, but two or more machines may have the same mean service rate. This is known as the *partially degenerate case*, since a balanced system is, in mathematical parlance, the completely degenerate case. In all three cases (general, partially and completely degenerate), the output increases as N increases and is ultimately limited by the service rate of the slowest machine. Using the data from Deerfield Mine, it is possible to calculate the outputs assuming partial and complete degeneracy and to compare them with the results already obtained for the actual (general) case. To begin with, suppose that all stages operate at the service rate of the slowest machine (loading, table II). Then, from table I, we have U = 0.67 for M = 4, N = 6 so that the output becomes 1.586 faces/hr or 45.65 tph. If only partial degeneracy is assumed, suppose the service times for loading, cutting, and bolting to be the same and equal to that of the slowest machine, but suppose the job of shooting to be carried out 25 percent faster. These figures are approximations of the actual values: 2.3772 and 2.9571 faces/hr. The output is then calculated to be 48.0 tph.

These two examples show how the effect of increasing the service rate of one machine can be evaluated. In going from the balanced system to the partially degenerate case, a transition which is actually made by speeding up the service rate of one machine, the output is increased from 45.65 tph to 48.0 tph. Under certain circumstances, therefore, an unbalanced system can be more productive than a balanced one. This principle must, of course, be applied with care, taking into account the actual service rates of the machines in the system. Where one machine is faster than all the others (which are balanced), output will be lost if it is made to slow down in an effort to achieve a completely balanced system.

Supposing now that one machine is a good deal slower than all the others (whether these all work at the same rate or not), it is also possible to calculate the effect of "doubling up" on the slowest machine. The basic equations derived from the model are amended slightly to include parallel service at one stage and the calculation must take into account that there is an additional possibility at this stage. Everywhere else, there are only the two probabilities that the machine is working or not working. For the stage with two service points, both, either or neither may be working, so that three probabilities exist. Using the data given in table III, the effects of doubling up on the blasting operation only have been calculated and are given in table IV for N = 6 and 9. For six-face operation, the output is increased from 77.25 tph by 8.25 tph to 85.50 tph. These results are also illuminating. Although dou-

TABLE II

CALCULATED RESULTS BASED ON DATA FROM DEERFIELD MINE

Job	Time per Face (min.)	Service Rate (faces/hr)	% Working Time or % Utilization N = 5	N = 6	N = 7
Loading	25.24	2.3772	67.0	71.3	74.3
Cutting	24.50	2.4490	65.0	69.1	72.5
Bolting	23.83	2.5178	63.1	67.2	70.2
Shooting	20.29	2.9571	53.8	57.2	59.9
		Output (tph)	45.8	49.0	50.6
		Actual Output (tph)	—	48.5	—

TABLE III

CALCULATED RESULTS BASED ON DATA FROM OLD BEN NO. 22 MINE

Job	Time per Face (min.)	Service Rate (faces/hr)	% Working Time or % Utilization N = 6	N = 7	N = 9
Blasting	28.1	2.135	72.3	76.4	84.3
Loading	25.6	2.344	65.9	69.6	76.8
Cutting	23.0	2.609	59.2	62.5	69.0
Drilling	19.8	3.030	51.0	53.8	59.4
Bolting	17.4	3.448	44.8	47.3	52.2
		Output (tph)	77.25	81.54	90.04
		Actual Output (tph)	80.0	—	—

TABLE IV

EFFECTS OF DOUBLING UP ON SLOWEST JOB (TWO BLASTERS), CALCULATED RESULTS BASED ON DATA FROM OLD BEN NO. 22

Job	Time per Face (min.)	Service Rate (faces/hr)	% Working Time or % Utilization N = 6	N = 9
Blasting	28.1	2.135	40.0*	45.9*
Loading	25.6	2.344	72.9	83.6
Cutting	23.0	2.609	65.5	75.1
Drilling	19.8	3.030	56.4	64.6
Bolting	17.4	3.448	49.6	56.8
		Total Output (tph)	85.50	97.95

*Each blasting "crew" works 40 (or 45.9) percent of the time. Since there are two crews, the output is 80 (or 91.8) percent of 2.135 faces/hr.

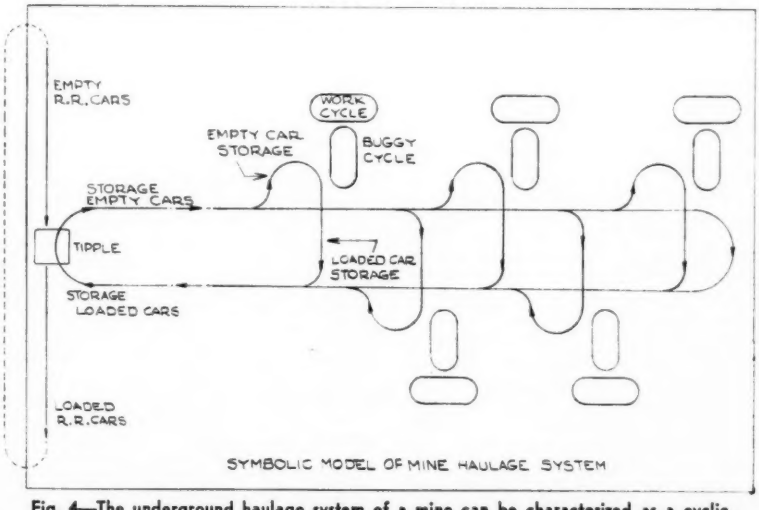


Fig. 4—The underground haulage system of a mine can be characterized as a cyclic system in terms of the movement of loaded coal cars from a loading point to the tipple and the return of empties to the loading point

bling up means that two blasting crews are waiting and therefore idle for 60 percent of their time, the overall increase in output may well be high enough to offset the extra costs involved in making the change.

General Considerations

All the results presented so far show that the output of the system increases as the number of faces worked is increased. This is certainly true as long as the service values of all stages are independent of the number of stages worked. In the present calculations, however, the service rates have been taken to include transport or "tramming" times and in practice these will increase as N increases (particularly in the loading stage) owing to the greater distances involved. The widening of the working area would also make it necessary to provide extra power take-off points, thus increasing the time needed for "maneuvering" and again decrease the service rates. The question of costs must also be considered where any of these theoretical results are to be put into practice. Apart from the extra power points, widening the working area may require additional track for loading mine cars or (in mines working a low seam) the provision, by blasting, of extra dumping points. Even if the working area is not extended but the solution of doubling up on slow stages is adopted, the cost of additional equipment and manpower must be weighed against the value of the increased output obtained.

Other Problems in Mining

The work described here is only the first phase of a more complete Operations Research study of mining operations. The Queue Theory approach to this analysis not only has applications in other industries but can also be used in other phases of mining operations. For example, the "equipment in use— overhaul—spare parts inventory" aspect of fleet operations in airlines and vehicle fleets can be regarded as a cyclic queue and is susceptible to such analysis. The same problem occurs in the servicing of mining equipment, where the lack of a working unit to replace that entering the overhaul cycle is also costly. Indeed, in an integrated mining operation, this cost is increased since the absence of one machine implies a loss of output from an entire section. The provision of an excessive number of spare machines, however, would tie up too much capital, so that the purpose of an Operations Research study would be to determine the optimum number of units in relation to their breakdown frequencies, overhaul times, etc. Again, the underground haulage system of a mine can be characterized as a cyclic system in terms of the movement of loaded coal cars from a loading point to the tipple and the return of empties to the loading point. At least some modification of the above approach would be necessary in the analysis, since the haulage system is more complex than the face operations and is represented by an extensive rail network.

The emphasis on Queue Theory in the above description should not lead to the belief that this is the only analytical technique Operations Research has to offer. Another very promising field for the application of Operations Research is, for example, in the development of new mining properties. The use of sequential sampling quality control may well augment the normal geological techniques used in exploration. This method enables limits to be set on the reliability of the data obtained from the initial samples in an exploration by comparing these with subsequent samples taken at prescribed positions in relation to the first. Again, the technique known as linear programming can be used to determine the most efficient or most profitable mode of operation of a mine-system, taking into account such factors as available tonnage and quality from each mine, transportation and blending costs and the demand and price structure for products of various qualities.

While the results of the present study are promising, therefore, perhaps their most valuable contribution is that they suggest other profitable areas for the future concentration of research efforts in the mining industry.

DRILLING TACONITES

(Continued from page 41)

sold on a sliding scale, large volumes would easily eliminate the difference. In addition, as we go deeper into our taconite formation, harder materials will be encountered and churn drilling will no longer be less expensive.

Power Loss Minimized in Down-the-Hole Drill

The down-the-hole drill is a drill attachment that actually goes down the hole with the bit. It is similar to any modern air-operated hammer drill but has all the moving parts near the bottom of the hole. The heavy drill piston, actuated by air, strikes the shank of the bit directly up to approximately 1000 blows per min. The significant feature of the tool is that the transmission of shock waves through rods and couplings is eliminated. Gauge loss on the tungsten carbide bit has practically been eliminated and bits can be worn to destruction. In addition, very little loss of power is experienced as the length of shock transmission has been reduced to a minimum. The vibration through the machine which always accompanied hammer drills, or drills similar to it, is completely eliminated. The attachment can be used on rotary drills. Although at present we have no down-the-hole drill at Pilotac, we have been watching this development with great interest.

The depth range of the drill is determined by the ability of the air to clear the cuttings from the hole. The above varies with the diameter of the hole, type of formation, and the volume of water encountered in the hole.

The drill works well in any formation where the wall of the bore hole does not cave. In hard rock the drill has performed satisfactorily; however, the rate of penetration and footage per bit have fallen down in our harder taconites.

The tool seems to be able to take over at a point in drilling where rotary bit cost begins to rise due to the change in the hardness of the material to be drilled. The combination of the rotary and the down-the-hole drill adds vastly to the versatility of the machine. However, limitations can be expected here also. We, in taconite, would be interested to see a 9-in. down-the-hole type machine developed. Indeed, the field is wide open to develop drills suitable for relatively softer taconites. Excellent footages per shift and long bit life have been reported using the down-the-hole drill in such soft rock formations.

No Universal Drill for Taconites

During the last ten years, drilling necessarily has become a specialized science on the Mesabi Range. The ratio of rock stripping to ore mined has been rapidly increasing. Indeed, the portion of ore to be drilled before mining also has been increasing. The day when drilling was a relatively small item on the cost sheet has disappeared. Improvements in drilling techniques are very much in demand. The function of drilling is no longer a small part of the total operation. However, the intense interest of management, the close cooperation between operators and manufacturers in improving the drills, the improvements made in bit design have all played important parts in reducing drilling costs. The progress made to date, plus the present interest in the drilling program, promises even greater improvement for the future.

Today there is no universal drill for taconite. With the wide range in structure of our taconites, we may need a drill in a particular area with certain drilling characteristics adapted to that area. These different requirements mean several types of drills are needed. Much work remains to achieve the optimum in drilling the taconites.

The Gas Hills Uranium District of Wyoming

Several large companies are active in the central Wyoming uranium district. Property acquisitions and consolidations now taking place form the basis for the future development of uranium mining and milling in the State

By J. A. MECIA
Manager
Mining Division, Utah Construction Co.

ONLY four years have elapsed since uranium was first discovered in the Gas Hills of Wyoming. During that short period the uranium industry has become an important factor in the economy of the State of Wyoming.

While those who have had the opportunity to observe the Wyoming uranium industry during its formative years may have at times believed the potential of the area was underrated by the mining industry, this certainly is no longer true. During the past year or two, several of our leading mining companies have acquired holdings in the area, and the Atomic Energy Commission has authorized construction of three uranium mills and is negotiating for additional milling capacity.

Because the area has only recently attracted attention as a major uranium-producing district, and because there are few authoritative descriptions of the area in government or trade publications, there is at present no commonly accepted name for the entire district. Strictly speaking, the Gas Hills district is but one of several productive areas in a uranium-rich region of about 10,000 square miles in central Wyoming. Geographically, most of the productive uranium mines are located in or along the edge of the Wind River Basin. Therefore, the uranium-producing area logically might be referred to as the Wind River Basin district. However, probably the most descriptive name is simply Central Wyoming Uranium district.

The Central Wyoming Uranium district is located in the geographical center of the state, a short distance east of the Continental Divide. The principal city serving the area is Riverton. Livestock, oil and gas have been the main industries of the region for many years.

Probably in every important mining district there is one individual who is singled out as being largely responsible for the district's development and success. In the district under discussion that person is Neil McNeice. Of course, there are others who share responsibility for the growth of the district, but it is doubtful that any of them will begrudge Neil McNeice the special recognition he so rightly deserves.

Mr. McNeice made the original uranium discovery while prospecting in the Gas Hills in September 1953, and since that time he and his associates have devoted themselves to seeing that the full potential of the uranium industry in central Wyoming is realized. The Lucky Mc Uranium Corp. was formed by McNeice and his partners in 1953, and today he serves as an officer of that company and exercises active leadership in the industry he helped to found.

Ore Characteristics Vary

Uranium miners in Wyoming are fortunate in that much of the ore discovered and developed to date has been relatively shallow and therefore lends itself to mining by open pit methods. The ore generally occurs in lenticular, flat-lying beds of variable thickness. Commonly the ore thickness is from one to ten feet, but in some areas the ore may be as much as 20 to 30 or more feet thick. Ore grade is also variable, ranging from 0.10 percent to higher than 0.50 percent U_3O_8. Average ore grade at most properties is probably between 0.15 percent and 0.30 percent U_3O_8, but some fortunate operators may be blessed with ore of somewhat richer average uranium content.

Commercial concentrations of ore are generally found in coarse grained, loosely consolidated sandstone in the Tertiary Wind River formation. Conglomerates, siltstones and carbonaceous shales of the Wind River formation are also sometimes found to be uranium bearing.

A discussion of ore genesis is beyond the scope of this article; suffice it to say that geologists have thus far been unable to agree upon the whys and wherefores of ore deposition in the Wind River basin. One theory often advanced is that uranium was deposited in receptive zones in the Wind River formation by surface waters that carried uranium leached from nearby volcanic or intrusive rocks. An imposing array of uranium minerals have been identified in ores

J. A. Mecia's early experience included one year with the Idaho-Maryland Mines Corp. in Grass Valley, Calif., and 11 years with the Bradley Mining Co. in Idaho. In 1952 he joined Utah Construction Co. As manager of its Mining Division, he is concerned with the mining and metallurgical operations of the company in the United States, Canada, South America and the Orient. These operations are engaged in the production of iron, coal, copper, tungsten and uranium.

from central Wyoming, the most abundant of which are reported to be uraninite (a uranium oxide) and coffinite (a uranium silicate).

Buying Program Aids Development

Credit for furnishing much of the impetus behind the rapid development of uranium mining in central Wyoming should be given to the Atomic Energy Commission's ore buying program. Many operators would have found it difficult, if not impossible, to explore and develop their mines had they not had a nearby market for the ores they mined.

The AEC opened its first Wyoming buying station at Riverton in March 1955. Deliveries to the station commenced slowly, but after a few months ore was coming in at a rate sufficient to swamp the station. The functions of the Riverton buying station have recently been assumed by Fremont Minerals Inc. A second buying station was opened by the AEC at Crooks Gap in December 1956. This buying station was closed soon after the Western Nuclear mill went into operation in July 1957.

The Central Wyoming Uranium district is currently passing through a transitional period not uncommon to mining districts the world over. It is a period of consolidation during which mine operators are finding it advantageous, or even essential, to either seek others as partners or to sell their holdings to the larger organizations that have the technical and financial resources required to successfully mine and market the ores.

It is not surprising that this should be happening, because with uranium ore, as with most other products, it takes know-how and capital to produce efficiently, and it takes a market in which to sell. In the case of the uranium miner, the market is a uranium mill. Milling capacity in Wyoming has in the past, is now, and probably will continue for some time in the future to be very much behind the ore producing potential of the area.

One way for the miner to assure himself a market for his ore is to ally himself with others who already have a mill or who have ore reserves sufficient to warrant new milling capacity. This is what has been happening in Wyoming.

Mine Production Exceeds Mill Capacity

The AEC is very much concerned with the problem of providing milling capacity for the ores of the independent mine operators, and AEC milling contracts provide that a certain proportion of a mill's capacity be devoted to the processing of outside purchased ores. Nevertheless, finding a market for their ore will be a serious problem for Wyoming uranium miners as long as milling capacity lags behind mine production.

At the present time, one uranium mill is in operation in central Wyoming, another mill is nearing completion and a third mill has been authorized. Negotiations with the AEC are underway for additional milling capacity, to be achieved by expansion of the present mills or by construction of new mills, or by a combination of expansion and new construction.

Western Nuclear Corp.'s mill north of Crook's Gap went into production in July 1957. The mill has a rated capacity of 400 tons of ore per day, and employs acid leach and resin in pulp circuits for uranium extraction and recovery. Ore for the mill is coming from several producers in the Gas Hills and Crooks Gap areas. Western Nuclear has submitted a proposal to the AEC for expanding its mill capacity.

Lucky Mc Uranium Corp. is constructing a mill in the central Gas Hills that will be in operation this spring. Design, engineering, construction and operation of the mill have been undertaken by Utah Construction Co. and its subsidiary, Utah Development Co. The mill will have a rated capacity of 750 tpd. Basic features of the mill flow scheme are acid leach and column ion exchange sections. Lucky Mc has proposed a mill expansion of 1000 tons per day to the AEC.

Fremont Minerals Inc., a subsidiary of Susquehanna Corporation, has successfully negotiated a contract with the AEC which authorizes Fremont to construct and operate a 500 tpd custom mill at Riverton. The mill will feature multiple circuits designed to

The ore generally occurs in lenticular, flat-lying beds of variable thickness and lends itself to open pit methods. Here, overburden is being stripped prior to mining

Wyoming uranium miners will have a difficult problem finding a market for their ore as long as milling capacity lags behind mine production. Lucky Mc Uranium Corporation's mill, shown near completion above, will help ease this situation

treat most of the varied types of uranium ores found in Wyoming. Another Susquehanna subsidiary, Mines Development Inc., operates a custom mill at Edgemont, S. D.

The three Wyoming mills with accessory facilities represent a total capital investment of about $20,000,000. Proposed expansions and new mills may be expected to increase the mill capital investment substantially in the future.

Mining Operations Are Described

A brief description of some of the mining operations may give some idea of past and present uranium activity in Wyoming.

Lucky Mc Uranium Corp. is in the enviable position of having one of the largest developed ore reserves in central Wyoming. Up to the present time the company has been concerned primarily with finding and developing ore reserves, rather than ore production. An extensive exploration program, involving several hundred thousand feet of drilling, has resulted in the discovery of sufficient ore to place Lucky Mc in the plus million ton ore reserve category.

In order to obtain financial and technical assistance in developing their properties, the original Lucky Mc partners entered into an agreement with New Park Mining Co. and New Park's subsidiary companies in April 1954. Limited mining of Lucky Mc ore was started in the spring of 1954 and the first ore shipment was made to Vitro's mill in Salt Lake City in July 1954. As exploration and small scale mining progressed it became evident that the ore reserve potential of the Lucky Mc properties was probably sufficient to warrant construction of a processing mill. Utah Construction Co., which now holds a majority interest in Lucky Mc, was called upon in late 1955 to conduct an expanded exploration program, negotiate with the AEC for a milling contract, arrange necessary financing, construct the mill, and operate both the mine and the mill.

Exploration in the Wind River formation is made difficult by the unconsolidated nature of the sediments. The Lucky Mc exploration and development drilling program was hampered by the necessity for recovering representative samples from holes drilled in loose, unconsolidated sands and gravels. Two-ft diam holes, drilled by "rat hole" rigs sometimes used in oil field drilling, were put down to check the samples from conventional rotary drill holes. Also, a unique frozen core drilling technique was successfully used for much of the drilling.

Two open pit mines are now being developed on Lucky Mc properties in the central Gas Hills. Stripping and mining at both pits is underway. A pit in the area of the original Lucky Mc uranium discovery has been opened up by a shovel stripping operation. Drilling and blasting is occasionally necessary but most of the overburden can be handled without shooting. About 6000 cu yd per day are stripped in this pit with one 2½-yd shovel working two shifts per day. Over 400,000 cu yd of overburden were stripped in 1957 preparatory to mining. The ore horizon lies under about 70 to 80 ft of overburden.

Stripping in the second, or new mine area, is done with scrapers. Five 26-yd scrapers move about 15,000 cu yd of overburden per day on a two-shift basis. The loading cycle requires the use of two crawler tractors pushing in tandem. About 1,400,000 cu yd of overburden were stripped in 1957. No drilling and blasting has yet been necessary in this pit. Ore occurs at several horizons in the new mine area, and it is planned to mine to a depth of about 120 ft.

Preliminary stripping in both pits is being carried down to about five ft above the ore. Test drilling on a closely-spaced grid is then done to precisely delineate the orebodies before final stripping is started. Extremely close control is required as prevention of excessive ore dilution is a serious problem, especially since it is difficult to differentiate between ore and waste by visual inspection.

In order to obtain maximum selectivity, ore mining and final stripping is done with small power shovels and front end loaders. Provision for pit drainage has been made in all mine planning for two reasons: part of the ore occurs below the water table, and flash floods are not uncommon in the region. Drainage ditches are maintained outside of the pit limits where it is anticipated that runoff might interfere with mining operations.

Vitro Minerals Corp. began mining operations in the Gas Hills in the spring of 1955. Since that time Vitro has consistently shipped more ore than any other Wyoming uranium producer, with most of the ore going to Vitro's Salt Lake City mill.

Vitro strips with two draglines, one equipped with a five-yd bucket and the other with a 2½-yd bucket. To some extent a cut and fill method is employed similar to that commonly used in coal stripping operations. A ¾-yd shovel is used for actual mining of the ore.

The deepest open pit uranium mine in Wyoming is the *Two States Uranium Corporation's* Redwood mine. Two States, an independent mine operator, has developed an orebody that in many places is more than 30 ft thick. The unusual ore thickness makes it economically possible to strip over 100 ft of overburden and to mine the ore with scrapers.

Not all mining is done by open pit methods. *Continental Uranium Co.*, subsidiary of Continental Materials Corp., operators of uranium mines in San Juan County, Utah, has completed a 240-ft vertical shaft preparatory to underground mining of its Crooks Gap orebody.

Globe Mining Co. was organized in January 1955 to mine one of the first orebodies to be discovered in the Gas Hills. Since that time Globe has been a consistent ore producer, and has developed substantial ore reserves as a result of extensive drilling activities.

Union Carbide Nuclear Co., one of the several companies to submit mill proposals to the AEC, proposes to build a 1000 tpd mill in the Gas Hills. Union Carbide Nuclear, a major operator on the Colorado Plateau, but a comparatively recent newcomer to Wyoming, has acquired large holding in the area, one of which is reported to be Globe Mining Company's large orebody.

Future Looks Good

There are several other producing properties as well as properties in the development stage too numerous to mention. Among the promising properties in central Wyoming are: the very large holdings of Wyoming Uranium Corp. and Phelps Dodge Corp. in the Crooks Gap area, the properties controlled by Federal Uranium Corp. and several affiliated companies, the Joe Wentz underground operations in the Gas Hills, and Western Nuclear Corporation's mines in the Crooks Gap and Gas Hills areas which supplies much of the ore for the Western Nuclear mill.

In summary, during the past four years the Central Wyoming Uranium District has become one of the major uranium mining areas in the United States. Drilling running into millions of feet has resulted in blocking out ore reserves in excess of six million tons, and potential reserves are probably several times that figure. Many mines are in production or under development. One mill is in operation, another is nearing completion, a third mill is authorized, and additional milling capacity is planned. Based on the record of the first four years, the future progress of the area seems assured.

CYCLONE CLASSIFICATION

(Continued from page 58)

Tables V and VI give the results of tests made under the two different conditions.

The cyclone test work in the regrind and cleaner sections of the concentrate circuit has proceeded to the point that installations are being made, using cyclones as the classification system in the regular regrind circuits. The results of the test circuit, to date, have opened up possibilities of much more compact regrind and cleaner flotation circuits. These new circuits would be especially advantageous in the case of increased tonnages being treated in the concentrator.

All Uses Not Yet Explored

There are other places in the concentrator where the value of cyclones can and will be investigated. The production of pyrite concentrate for the acid plant, the grinding and sizing of high-grade silica for spray material at the smelter, the grinding and hydrating of lime to produce a uniform product for the concentrator and many possibilities in the circuits of the flotation middlings sections, are some opportunities for investigation. Eventually, in every concentrator, some phase of tailing's treatment or disposal work offers opportunity for classification and cyclone studies. Chuquicamata is not an exception. Already tests have been made for elimination of sands to the thickeners, and also tests for recovery of values in the coarser sizes of the tailings.

TABLE V

REGRIND SECTION—CONCENTRATE—One 24-in. Cyclone in Circuit

Control Data			
	Pressure at cones:	11 psi	
	Inlet nozzle:	24 sq in.	
	Vortex:	5½-in. diam.	
	Apex:	3-in. diam.	

Screen Analysis and Flow Data

		Cyclone Circuit		Classifier Circuit
	Feed	**Overflow**	**Underflow**	**Overflow**
GPM	690	593	97	
% Solids	35.6	19.7	76.4	20.3
Dry Short Tons/Hr	35.2	38.4	46.8	35.0
Mesh		**% Wt**		**% Wt.**
Plus 200		8.0		12.5
Plus 325		14.5		19.3
Minus 325		76.5		68.2
Circulating Load in Ball Mill Circuit		160%		100%
Assays—Concentrates				
% Total Copper		41.6		36.2
% Iron		18.9		21.7
% Insoluble		5.7		6.7

TEST RESULTS: When the overflows of both the classifier and cyclone circuits were operated with 20 percent solids, the weight of the plus 200 mesh fraction in the cyclone circuit was lower than that of the classifier circuit. The copper concentrate grade of the cyclone flotation circuit was also 5.4 percent higher than that of the classifier circuit.

TABLE VI

REGRIND SECTION—CONCENTRATE—One 24-in. Cyclone in Circuit

Control Data			
	Pressure at cones:	15 psi	
	Inlet nozzle:	21 sq in.	
	Vortex:	6-in. diam.	
	Apex:	3-in. diam.	

Screen Analysis and Flow Data

		Cyclone Circuit		Classifier Circuit
	Feed	**Overflow**	**Underflow**	**Overflow**
GPM	705	612	93	
% Solids	32.7	24.3	75.1	19.6
Dry Short Tons/Hr	76.8	34.2	42.6	33.4
Mesh		**% Wt**		**% Wt.**
Plus 200		10.4		10.3
Plus 325		16.2		18.8
Minus 325		73.4		70.9
Circulating Load in Ball Mill Circuit		130%		80%
Assays—Concentrates				
% Total Copper		37.1		34.1
% Iron		22.1		23.2
% Insoluble		6.7		6.5

TEST RESULTS: Both classification circuits were maintained with the same percent by weight of plus 200 mesh sizes. In the cyclone circuit the overflow had a higher percent of solids. The final concentrate grade was also higher in the cyclone flotation circuit.

An Application of the Cryderman Mucker in VERTICAL-SHAFT SINKING

Early difficulties in handling and in gaining operator acceptance of the machine were overcome and a one-man mucking operation resulted

By JOHN W. BADER
Project Engineer
Western Mining Divisions
Kennecott Copper Corp.

THE Burgin shaft, at Bear Creek Mining Company's East Tintic Exploration Project, has been recently completed under a contract held by Centennial Development Company of Eureka, Utah.

The shaft was sunk vertically 1100 feet in 142 working days. Three shifts per day worked six days per week throughout the project. The excavated rock section of the shaft measured approximately 7 by 16½ ft. This was divided into two 5 by 5 ft hoisting compartments and a 3 by 5 ft manway.

The bottom was divided into two benches with a 3½ ft elevation difference between them. The benches alternately advanced seven feet per round, maintaining the staggered spacing and providing a sump for inflowing water so that the drillers on the opposite bench could usually work on a dry footing. At the beginning of the project, the work was tentatively scheduled for two shifts to advance the sinking; drilling, blasting and mucking a round each in an eight hour period. The third shift was to install timber, service lines and accessories.

Operation Described

A Cryderman vertical-shaft mucker, suspended in the manway compartment, was used throughout the project except for one week when another machine replaced it. The Cryderman consisted of a two piece, 20-ft long, box shaped cage built of angle sections. On the lower end of the cage a telescoping boom was attached to a gimbal mounting. Motions of the boom and its clam-shell bucket were controlled by an operator handling two "joy-stick" levers. These levers, operating multi-directional valves, controlled seven air cylinders. Four cylinders moved the boom; another provided the telescoping portion with up to an 8000 lb thrust, and two others powered the "bite" of the clam-shell jaws.

The first stop in the active career of John W. Bader was at Balmat mine of St. Joseph Lead Co. in northern New York. During the next four years he served as mining engineer at International Salt Company's mine in the same state. As a designer and field man he has worked on several construction jobs, including the St. Lawrence Seaway. Bader joined Kennecott Copper Corp in 1956.

The standard cage of the Cryderman measured 30 by 58 in. When used in a vertical shaft, it is generally advised that the frame be built out with falsework to fill the compartment space in which it is operated. This prevents the frame from being thrown about in the compartment by the back thrust of the boom. It also facilitates hoisting or lowering by keeping the frame aligned with the shaft. The operator stood on a platform at the bottom of the cage. An air driven tugger hoist, mounted just above him, raised and lowered the machine by means of a six part one-half-in. wire rope tackle. The upper sheave block was attached to a steel beam centered across the compartment and bearing on wall plates. The drum of the tugger hoist carried sufficient rope to allow operation of the machine through 60 ft of shaft without moving the supporting beam. To advance the beam, the cage needed only to be brought to rest on blocking. The rope tackle could then be shortened and the beam and sheave block remounted in a lower position.

It was practice during blasting to raise the machine at least 40 ft from the shaft bottom.

Advantageous in Confined Space

In the mucking operation only one hoisting bucket was used throughout the entire 1100 ft of shaft. The bucket was never detached from the hoist rope. The decision to use a single bucket was due primarily to the confined space at the bottom of this shaft. Although the mucker was idled during the traveling time of the bucket, the system had the advantage of requiring only one man to perform the mucking operation. The operator could normally muck a round clean without assistance from any helpers on the shaft bottom. In a larger shaft, efficiency would have required the use of two buckets. In such event, two men on the bottom would have been needed for bucket changing. The self-sufficiency of the Cryderman operator in this project, however, left the remainder of the crew free to do accessory work such as placing lagging, piping or vent tubing. Because much of the accessory work could be completed during the mucking period, the third shift crew was frequently free to complete a con-

siderable portion of the sinking cycle.

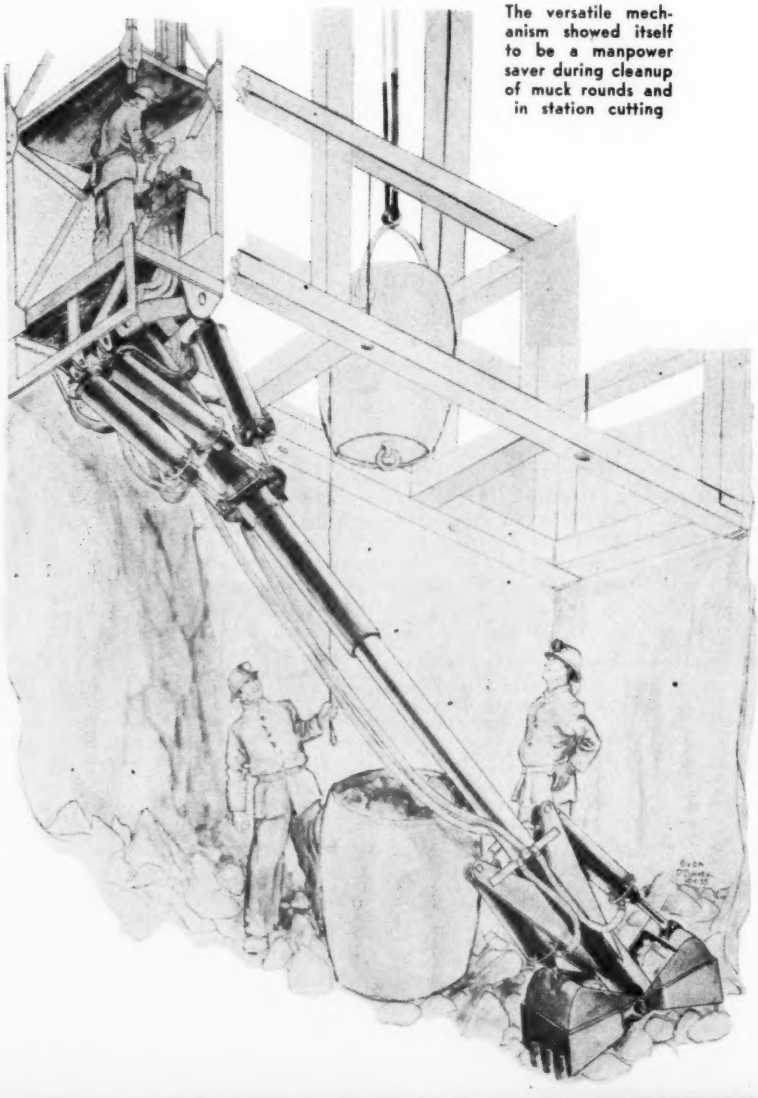
Early in the course of the project, water was removed from the sump by two men filling the hoisting bucket with the aid of a small submersible pump. It developed however, that the Cryderman operator could bail water as easily with the clam-shell. This feature also proved very useful for washing down the benches in preparation for drilling.

Although there was little tendency for the ground to break in a blocky form, it was noted occasionally that the powered "bite" of the clam jaws permitted easy withdrawal of large chunks from the muck-pile.

Early Difficulties Overcome

It is understood that the Burgin shaft had the narrowest cross-section in which a Cryderman has yet been used. This close confinement was partly responsible for some machine breakdowns that at first tended to discourage the contractor with its use. The sensitive and rapid response of the machine to the controls caused inexperienced operators to strike hard against the shaft walls when swinging the boom. This caused structural failure of a few parts of the boom and its gimbal mounting. Gussets and cover plates were added at the critical points by the machine's vendors, Shaft and Development Machines, Inc. of Salt Lake City and thereafter most of these troubles were eliminated. It has since been recommended that the shut-off valve in the air supply line be a slow acting type that will produce a throttling effect. The restriction of the air flow passing this valve will then slow the movements of the machine while the new operator is gaining the "feel" of its controls and the dangers of his inept handling should be greatly reduced.

A very conservative pattern of machine motion was developed during the progress of the job. The operators learned to dig along the long axis of the shaft section, allowing the muck to run to the center as the cut deepened. With the bucket placed on the center line, it could be loaded from the far bench simply by retracting the boom and spilling the clam or from the near bench, by retracting and swinging the clam slightly forward. Lateral motion was unnecessary except during the clean-up of a round.



The versatile mechanism showed itself to be a manpower saver during cleanup of muck rounds and in station cutting

Effectively Used in All Shaft Mucking

The boom of the vertical-shaft Cryderman, unlike those used in inclines, is built of circular tubing and the telescoping portion, on which the clam bucket is mounted, is free to rotate. This rotation can readily be controlled by an experienced operator, as he swings the boom, by touching the bucket to the shaft wall and rolling it into the desired position. Such positioning of the clam jaws permits a very thorough clean-up of a muck round. The machine is usually hung near one end of the shaft-section with the pivot of the boom not more than six ft from the end wall. This position allows the mucker to reach into the back corners and also affords the operator a full view of the shaft bottom.

When fully extended, the 32 ft boom has a 27 ft horizontal reach forward. Laterally it can reach up to 14 ft. The 14 ft side reach allows the machine to muck the first few cuts in a shaft station, provided that the corner formed by the shaft wall and the station back is high enough to clear the boom. In the Burgin shaft, a small slusher was installed on the station floor and all of the station muck was scraped within reach of the Cryderman.

The effect of the operators' reactions to the machine on progress of the shaft sinking is interesting to note. During the first two months of shaft work the new operators expressed much dissatisfaction with the performance of the machine. Progress during this period averaged only about 6.4 ft per day. At the end of this time a breakdown necessitated the removal of the Cryderman from the shaft for repairs and another type of mucker was substituted. It was contemplated that the second machine would be retained until the shaft was completed. However, progress continued unimproved. At the end of the first week's use of the substitute machine, the shaft crews approached the contractor with the offer that they would complete 10 ft per day if he would put the Cryderman back in service. Their offer was slightly over-optimistic. On a number of occasions they surpassed their 10 foot quota, but their average in the last two months was 9.4 ft per day. Nonetheless, this performance marked nearly a 50 percent increase in output, mostly due to the operator's acceptance of the machine.

Major Factors in Belt Conveyor Haulage

West Kentucky Coal Co. experiences less than one percent downtime resulting from conveyor delays. Competently trained belt crews have been chiefly responsible

By J. W. BASSETT

Mining Engineer
West Kentucky Coal Co.

IN 1940 the first all-belt haulage was found in West Kentucky Coal Company's North Diamond mine. The operation was equipped with a 42-in. mother belt and 30-in. gathering belt, after about one year of experimental work. This haulage system was very similar to our present systems, except that the company is going to 36 in. gathering belts. It is noteworthy to mention that 75 percent of that original 42 in. belt and all of the drives and 42 in. belt framing are still in operation at our Pleasant View mine. It is reasonable to expect that the drives and framing will last another 17 years.

Continuous Flow of Coal

With the high degree of mechanization today, there must be a continuous flow of coal away from the face area. The only delays that can be accepted are the unavoidable mechanical delays of face equipment. With all-belt haulage our company experiences less than one percent downtime resulting from belt delays.

There are two simple devices that keep our belt delays to a minimum, assuming proper belt and drive were originally installed and are properly maintained and lubricated. First, centrifugal switches stop a belt when the belt in front of it stops, and, second, a paddle switch will stop a belt when a chute or spillboard allows a flat piece of slate or gob to hang.

It is of utmost importance not to overload panel belts. This is the most frequent source of belt delays. Of primary importance is cleanliness. Idler rollers must always be kept free. It is surprising how quickly a panel belt becomes overloaded when the belt drags on coal or on stuck idlers.

The most fool-proof method to avoid overloading and pulling panel belts in two may be accomplished with a tong tester. When a tong tester indicates that the motor on a belt drive is overloaded, an inspection will usually indicate one of three problems: (A) Too much belt for grades, (B) belt line not clean or (C) idler rollers have not had their proper lubrication. Combine these practices with an inspection for bad splices each shift, and 90 percent of your panel belt delay will be eliminated.

Grade extremes over which the company has pulled coal with conveyor belts should also be mentioned. In

Safety at transfer points dictates keeping all combustible material cleared from motors, cables and head pulleys

Pilot lines near the roof minimize the danger to belts from roof falls

Centrifugal switch—a protective device that stops a belt when the belt in front of it stops

Stony Point mine, which was recently closed, some extreme local grades of as much as 40 percent were encountered. In the main west entry there were 2000 ft of 36 in. belt. The total grade was in favor of the load. The entry was characterized as having one hill after another. In this hilly country the mine had no trouble with the belt haulage; the problem was preparing coal and hauling it to the belt.

Accident Prevention—Safety Controls

The accident rate attributed to belt haulage is nil. At our Pleasant View mine there have been two lost time accidents in the past three years attributed to belt haulage. During this period 4,500,000 tons of raw coal were pulled over the belts. This will compare favorably with other types of haulage which show an accident rate second to roof fall.

Engineers set spads for all-belt drives, counter-balance pits and belt-conveyor alignment before any work of this type is done. All entries are inspected and retimbered, if necessary. A regular crew of well-trained men makes belt extensions, splices, sets belt drives, and keeps conveyor frames properly aligned and adjusted.

In extending or taking off belt, all switches must be pulled to avoid friction, fires and other hazards. Belt lines are well lighted. Cross-over platforms are installed where men need to frequently cross over the belt. All belt underpaths or passes where men or equipment have to travel are guarded with sideboards to prevent coal or other material from falling off the belt.

Belts are interlocked with a central panel control. Should the main mother belt stop, all others automatically stop and cannot be started until the main belt is again in operation. All belts are equipped with control switches at convenient places so that they may be stopped quickly.

All belts have pilot lines directly near the roof. These lines will stop the belts should a roof fall occur, thereby minimizing the danger to belts from roof falls. All conveyor belts from the portal to the face are paralleled with a two-in. water line alongside with outlet valves and hose at intervals.

Belt transfer or loading points are equipped with automatic water sprays, controlled by solenoid valves, which operate when the belt is loaded. Each transfer or discharge point is equipped with an overflow paddle switch to prevent a coal pile-up or choking of a transfer point. An attendant or operator is stationed at each transfer point whose duty it is to keep all combustible material cleared from motors, cables, head pulleys, loading points and tail pieces. These places are regularly inspected. All transfer points are equipped with telephone service which is maintained throughout the mine and connected to the surface.

Advantages of Concentrated Mining With Belt Haulage

Belt haulage limits mining to that area which can be reached by the belt on hand. In a 1,500,000 to 2,000,000 ton per year mine, the entry development can only be in one direction at a time. As you retreat from one set of main entries you must develop another set of mains to provide mining territory. This tends to keep units close together and gives better supervision. Belt haulage forces supervisory personnel to plan ahead and thus their ability to visualize what must take place in the future is guaranteed.

In order to have good underground supervision the mine foreman and assistant foreman should visit working places as many times during the shift as possible. In our belt mines it is not uncommon for the assistant mine foreman to visit each of eight working sections four times each day. In the morning the mine foreman and assistant foreman start at opposite ends of the mine. If any particular problem arises during the day, one of them will be above the problem by belt and by riding belts can be any place in the mine in 10 or 15 minutes —which brings us to the subject of belt riding.

In Kentucky, as in other states, there are laws governing belt riding as to speed of belt and height over belt at getting-on and getting-off points. Generally the speeds are impractical; that is, separate motors and speed reducers would have to be hooked to the present drives to reduce belt speeds to comply with the law.

However, generally speaking, normal belt speeds for transporting coal are not too fast to ride; also, in any mine where supervisory personnel ride belts, there is ample head room at getting-on and off stations. Belt riding is particularly applicable to slope belts and should be permitted. Due to the fact that slope belts provide a continuous and safe method of transportation from the top to the bottom of the slope, we definitely endorse it.

Cost of Conveyor Belt Haulage

Capital Expenditure. A purchaser can expect to pay $76.50 per ft for 42-in. mother belt. This includes rubber, drive, tail roller, motor, electrical equipment and all other incidental items. For 36-in. gathering belts the cost is $45 per ft.

Installation Cost. For 42-in. mother belt and based on 4000-ft. centers, the installation cost will be about 85 cents per ft. Based on 2000-ft centers, 36-in. gathering belt will be 50 cents per ft.

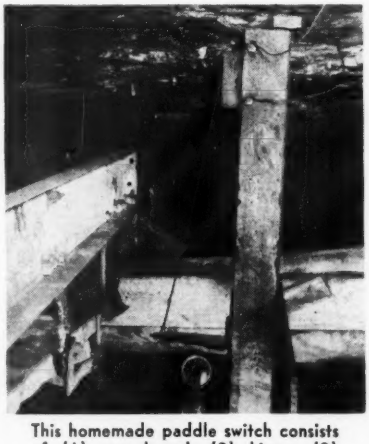
Proper belt maintenance — i.e., to advance and retract them, keep them clean, grease, and resplice—will show up in mine cost as approximately 20 cents per ton to take coal from shuttle car to the tipple. This will include all replacement of belt idler rollers and belt. This average figure is based on a 1,500,000 to 2,000,000 ton per year mine.

Life Expectancy for Belt Haulage Equipment

This will naturally vary with abuse; however, the original 42-in. belt our company purchased in 1940 is still running and in good condition. Panel belts are subject to the greatest abuse and can be expected to last eight to ten years. At any rate the figure of 20 cents per ton will take care of replacement and maintain equipment in good working order.

Conclusion

It may be said that after you have competently trained belt crews, you can expect less than 1 percent downtime resulting from using belt haulage. At present day prices the 42-in. belt will cost $77.15 per ft to buy and initially install, and $45.50 per ft for the 36-in. Then there will be a cost of 20 cents per ton to operate and maintain.



This homemade paddle switch consists of (1) cap board, (2) hinge, (3) piece of scrap wire and (4) knife switch. It will stop a belt when a chute or spillboard allows a flat piece of slate or gob to hang

Operator's Corner

Reliable Push Button Starting Depends on Battery Care

Cold weather starting of diesel powered crawler tractors and other earthmoving equipment places heavy demands on storage batteries. Here are some maintenance tips on how to get peak winter battery performance

By ROBERT H. HAWKINS
Manager
Central Division, Service Department
Caterpillar Tractor Co.

MACHINE owners have come to expect convenience and dependability when starting diesel engines in all weather, regardless of temperature extremes. Some machines come equipped with gasoline starting engines while others depend on cranking the diesel with electric starting motors. Even gasoline starting engines often have their own direct electric starting systems. In fact, most electric starting systems are dependent on one source of power—the storage battery.

In cold or heat, rain or snow, dependable batteries are ready to supply the needed energy for cranking. But, if batteries are forgotten, neglected, or mistreated, they may fail at a most critical time.

Let's see what a storage battery does. A storage battery is a reservoir used for storing energy for use at a later time. Electrical energy is put into it or drawn from it, but the actual storage process is a matter of chemistry.

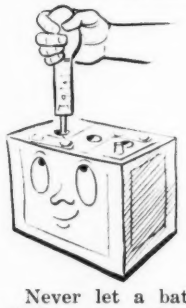
A storage battery has a limited capacity (the quantity of electricity which can be taken from it in a given period of time) just as a water storage tank can maintain a flow of so many gallons per minute for only a certain number of minutes. The capacity of a battery (sometimes called its electrical size) is usually listed in "ampere-hours." This term is used to specify the amount of current a battery will deliver continuously for a definite number of hours or minutes. Capacity depends on how well the battery is constructed, its age, the size of the plates, and how many plates are assembled in each cell.

Why do storage batteries run down? Frequently the problem is the same as with any storage system: If more is taken out than is put back in, the reservoir for storage ultimately becomes empty. Added electrical load, such as lights, heaters, two-way radios, sometimes impose more drain on the system than can be replaced by the generator. There are other reasons. The first is age. After many hours use, the storage capacity is reduced. A second reason may be internal faults which continually drain off the electrical supply. Finally, improper maintenance and operation make a battery "age" quickly.

Turn to next page for rules of battery care.

ANY BATTERY REQUIRES SOME ATTENTION FOR CONTINUED SATISFACTORY SERVICE. HERE ARE A FEW NECESSARY RULES FOR ITS CARE:

KEEP BATTERY CHARGED



Maintain the battery in a normal state of charge—the specific gravity should be above 1.225—by keeping the generator output and voltage regulator in proper adjustment.

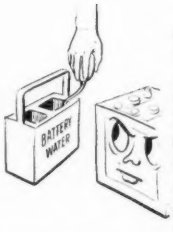
Never let a battery remain in a discharged condition for an extended period of time. The discharge action of a battery sulphates the plates but this can be driven off if the battery is charged soon after discharge. However, if the battery is allowed to remain too long in a discharged condition, the sulphate becomes hard and is very difficult, if not impossible, to drive off the plates during charging.

Batteries have much longer service life if they are kept at or very near full charge at all times. In normal operation of equipment, some discharging and charging of the battery takes place continuously, but the battery is not discharged to a great extent at any time. However, cycling a battery (regularly discharging it almost completely and then recharging it) will seriously affect its service life.

CLEANLINESS COUNTS

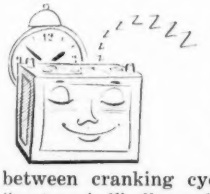
Wash the battery occasionally with a "baking soda" solution (one pound of soda to one gallon of water) to neutralize the acid which is present on the case, and then rinse it with a stream of cold water. Cleanliness also includes the terminals. Wire brush them until corrosion is removed and then coat them with petroleum jelly.

PERIODIC CHECK



A most important step in extending battery life is a periodic check of the electrolyte or water level. Nearly all storage batteries have a reserve space for water in the top above the plates, and most battery manufacturers recommend that water be added until it is ⅜ in. above the plates. Be careful not to overfill the battery because this allows the electrolyte to splash out and corrode all metal it contacts. Continued overfilling will result in so much loss of acid that the electrolyte may no longer be strong enough for the battery to deliver the required energy to crank the engine. If the battery requires water more often than once every two weeks, the charging rate is too high.

ALLOW REST

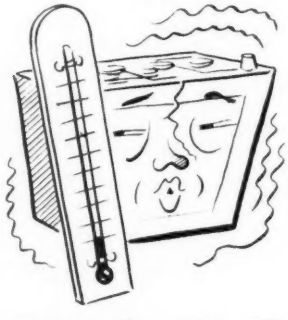


Never use the electric starter more than 30 seconds at a time and then allow approximately two minutes between cranking cycles. The brief "rest period" allows the battery plates to cool and allows the battery to recuperate sufficiently to again deliver a surge of power.

After emergency use or accidental energy loss, such as leaving lights on overnight, it might be necessary to "quick charge" the battery. No particular fault can be found with "quick charging" or "hot charging" methods providing the manufacturer's instructions are closely followed.

PREVENT FREEZING

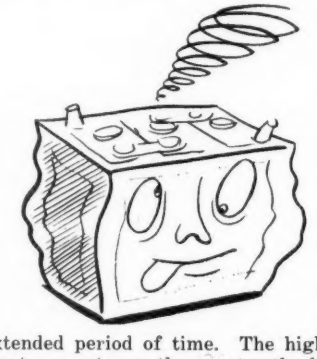
In cold weather, never add water at the end of a day's run. Instead, add water in the morning just before starting or right after starting. In



this manner, the water will be thoroughly mixed with the acid by the end of the day's run and freezing of the electrolyte will be prevented.

STORAGE PROCEDURES

Storage batteries which are not in use will lose their strength gradually (the rate of discharge depends upon the temperature) when left on the shelf or stored in machines for an



extended period of time. The higher the temperatures, the greater the loss of energy. To keep them up to strength and ready for use, recharge any batteries in storage when their specific gravity drops to 1.240. A fully charged battery will show a hydrometer reading of 1.270 to 1.280.

Wheels of GOVERNMENT

As Viewed by HARRY L. MOFFETT of the American Mining Congress

WITH the Army's launching of a U. S. earth satellite, Congress and the Administration have veered away from major concern with sputniks and have turned their attention to means of halting rising unemployment and reversing the recessionary trend in our economy.

Proposals are being advanced on Capitol Hill for public works and housing projects to spur employment, and a strong tide is flowing towards tax reductions for individuals. The Administration, however, is taking the position that an upturn is in the offering and that tax reductions should not be voted unless economic activity continues to slide.

The sharpest battle of the 85th Congress was joined on February 17, when the House Ways and Means Committee began hearings on an Administration bill to extend the Trade Agreements Act for five years and to authorize U. S. participation in the Organization for Trade Cooperation (OTC). With an increasing number of U. S. industries suffering harm from imports, opposition to the trade act in its present form has grown tremendously. Administration officials have taken cognizance of this trend and have indicated that the White House may be amenable to some compromise.

Both Congress and the Administration are showing new interest in developing a long range minerals program. Interior Secretary Seaton, at a recent press conference, said his Department is formulating a new minerals plan but that its submission to Congress will await action of the Tariff Commission on the pending petition of the lead-zinc industries for escape clause relief. It is understood that the Department's program will be submitted on a case-by-case basis for the minerals and metals believed to need some form of Government aid.

Meanwhile, the Senate Interior Subcommittee on Minerals, Materials and Fuels will begin hearings March 24 on measures "to restore the economic health" of the mining industry. Interior Secretary Seaton and Commerce Secretary Weeks will be the first witnesses before the Committee. Senator Murray (Dem., Mont.), chairman of the subcommittee, expressed the hope that the hearings will result in a legislative program "which will give strength and stability in peacetime to our all important minerals extractive industry" and will provide a strong mobilization base for any emergency.

Washington Highlights

TRADE ACT: Faces bitter battle.
NATURAL GAS ACT: Stalled in House.
PRICE DISCRIMINATION BILL: Kefauver seeks approval.
MERGER LEGISLATION: Rests in Rules Committee.
DEFENSE PRODUCTION ACT: 2-Yr. Extension sought.
AEC POLICIES: Being reviewed by Congress.
STOCKPILING: Advisory group makes recommendations.
FREIGHT RATES: Boosted.
INTERIOR FUNDS: Slashed slightly.

In the field of taxation, the House approved and sent to the Senate the Mills bill, to remove unintended benefits and hardships created by the 1954 Revenue Code. The Senate Finance Committee held hearings beginning February 25, and the Mining Congress together with other interested groups testified on February 27, asking the Committee to approve an amendment more adequately correcting the deficiencies in the present definition of the "property" which forms the depletion unit.

TRADE ACT HEARINGS BEGIN

The Administration, during the first week of the Trade Agreement hearings, brought up its big guns in support of a full five-year extension with broadened tariff-cutting authority for the President. Urging enactment of the bill were Secretary of Commerce Sinclair Weeks, Secretary of Defense Neil McElroy, and Secretary of Agriculture Ezra Benson, together with Treasury Under Secretary Julian Baird, Interior Under Secretary Hatfield Chilson, and Gordon Gray, director of the Office of Defense Mobilization.

Gray, during his testimony, said that although ODM at this time "cannot find that imports of residual fuel oil into the United States are in such quantities as to threaten to impair the national security, we have initiated a reporting service to watch the trend of such imports."

Chilson devoted most of his testimony to the current situation with respect to minerals. Those who argue that operation of the Trade Agreements Act is crippling domestic minerals producing industries, he said, "do not take into account that many of these problems are due to the past years in which we experienced a rapid expansion of demand, followed by the stimulation of increased productive capacity, and then a decline in demand."

Although many metals and minerals have not been subject to tariff concessions, any proposals to make new or additional concessions will be most carefully scrutinized, Chilson declared. The Interior Department is constantly reviewing the mineral position of the United States along with developments abroad, he added, and opined that "with an upturn in our economy the problems of some mineral surpluses can quickly turn to problems of scarcity."

Some of the Committee's 25 members have made it plain that they will attempt to have the bill amended so that domestic industries, including mining, will have greater protection from excessive imports. Administration witnesses have registered strong opposition to amending the bill to provide for Congressional instead of Presidential review of Tariff Commission findings on "escape clause" or "national security" petitions. Most Washington observers believe the fight over this bill will be the most strenu-

ous legislative battle of the year.

Dozens of witnesses representing industry, agriculture and labor are scheduled to appear before the hearings are ended March 20. A large number of representatives of the mining industry are planning to testify.

NATURAL GAS BILL STALLED

The future of the natural gas bill during this session of Congress remains in doubt as a result of the recent "appreciation dinner" held in Texas for House Minority Leader Joseph W. Martin. The bill would amend the Natural Gas Act to give natural gas producers more freedom from Federal Power Commission regulation.

The Texas dinner, which raised more than $100,000 in political contributions, was being held, according to a letter of invitation to honor Martin for his past support of the gas bill and his anticipated future efforts in lining up House members in favor of the measure. A political furore immediately developed, and House Speaker Sam Rayburn said the incident would at least "cause delay" in plans to bring up the bill for a House vote. After learning of the contents of the invitation, Martin said the bill is dead for this session of Congress.

Also in the news have been the hearings held by the Borden Royal Commission in Canada which is investigating the natural gas and oil resources of that country. The hearings are the result of an application filed with the U. S. Federal Power Commission by the Tennessee Transmission Co. to bring Canadian natural gas to the midwestern United States. The pipeline company had reached an agreement with the Liberal government in Canada for the importation of the gas. When the Conservative government took over it put a "stop" order on the agreement pending the Borden Commission findings.

Hearings on the transmission company's application before the Federal Power Commission were concluded late in January following testimony by representatives of the coal mining industry, the mine workers, the upper lake coal-dock industry, and coal carrying railroads. The final decision of the Federal Power Commission is not expected until late Summer or early Fall.

PRICING BILL ACTIVE AGAIN

As this is written the Senate Judiciary Committee has scheduled the so-called price discrimination bill (S. 11) for consideration on February 24. The bill, introduced by Sen. Kefauver (Dem., Tenn.), would seriously limit the use of the "good faith" defense in price discrimination cases and would cast serious doubt on the legality of the long-established practice of freight absorption to meet competition.

Extensive hearings were held last year by the Antimonopoly Subcommittee of the Judiciary Committee and the bill was reported without recommendation to the full Committee, which took no action. It is possible that efforts will be made to amend the bill in Committee this year to make it applicable only to certain specific items or business fields in an effort to soften opposition to the measure.

Committee consideration of the bill was probably spurred by a recent decision of the Supreme Court, which in effect reiterated a 1951 Court decision that the "good faith" defense is a complete defense in meeting the equally low price of a competitor. The Federal Trade Commission, which supports the bill, has held in many decisions that the "good faith" defense is no defense if the lowering of prices injures competition.

MERGER NOTIFICATION BILL DORMANT

The House Rules Committee has taken no action on the pre-merger notification bill which was referred to it last year, and committee members have given no indication as to when the Committee will act. The Rules Committee determines how much time is to be allocated for debate on a bill and whether amendments to the bill may be offered from the floor.

The Senate Small Business Committee, in a recent report filed with the Senate, urged passage of such legislation. The report expressed "deep concern" over what it termed a high rate of mergers, saying, "If our giant corporations can conceive of continued profitable operations only in terms of combinations, on what grounds can the average small businessman base his hopes for the future as an independent self-contained economic entity?" The report also urged the Department of Justice and the Federal Trade Commission to prosecute more vigorously any violations of the antitrust laws and asked the Justice Department to re-evaluate its actions in regard to consent decrees.

The bill before the House Rules Committee would require 60 days prior notification to the Federal Trade Commission and the Attorney General of proposed acquisitions or mergers of corporations having combined capital structures of over $10,000,000. An American Mining Congress amendment accepted by the Judiciary Committee would provide an exemption for "any acquisition of (i) stock or other share capital of a corporation, 75 percentum or more of the market value of the assets of which consist of undeveloped or partially developed mineral, mining or timberland properties, or (ii) the whole or any part of such undeveloped or partially developed mineral, mining or timberland properties."

DEFENSE PRODUCTION ACT EXTENSION URGED

ODM Director Gordon Gray has written Vice President Nixon requesting Congress to extend the Defense Production Act for another two years. He pointed out that the Act provides much of the basic authority for bringing about expansion of productive capacity and for providing controls over scarce materials.

It is under the terms of the Defense Production Act that loans are made for exploration of mineral properties, that authority is available for mineral expansion programs, and that priorities and allocations may be instituted.

AEC POLICIES STUDIED

The Joint Congressional Committee on Atomic Energy has commenced hearings into AEC policies and the development and present position of the atomic energy industry in the United States. The Committee makes an annual review of such matters, and this year many of its members are openly critical of AEC policies dealing with reactor construction and the uranium buying program.

A long list of mining witnesses is scheduled to appear before the Committee late in February to set forth the industry's views on the uranium purchase program, the AEC policy with respect to new mills, and the possibility of commercial sales of uranium.

Recently Jesse Johnson, AEC raw materials director, announced that the agency is considering permitting sales of uranium in commercial markets. He stated: "Since domestic concentrate now can be produced in greater quantity than required for AEC contracts, one of the principal reasons for the Commission being the sole buyer has been removed." He pointed out that permission to sell uranium commercially hinges upon the development of a licensing system which will safeguard sales made for export.

STOCKPILE RECOMMENDATIONS MADE

A number of recommendations dealing with the stockpiling of strategic and critical materials were presented recently to Defense Mobilization Director Gordon Gray by the Special Stockpile Advisory Committee which he appointed last Fall. The recommendations are not binding on Gray, but are expected to receive his careful consideration.

The Committee was made up of 12 men from outside of the Government. Their report urged that in stockpiling, the emphasis be shifted from raw materials to finished items and vital supplies for survival, relief and rehabilitation. They said that the supply expansion programs initiated during

(Continued on page 84)

AMC Personals

Bethlehem Steel Co., has made known several recent appointments in Bethlehem Mines Corp.

L. H. Chalfant has been appointed manager, succeeding **T. J. Crocker**

L. H. Chalfant

E. R. Luy

whose retirement became effective February 1. **E. R. Luy**, superintendent of the corporation's Barbour-Randolph Division, in West Virginia, replaces Chalfant as assistant general manager. Luy, in turn, has been succeeded by **Henry R. Hall**, formerly superintendent of the No. 44 mine at Idamay, W. Va.

James F. Wildey has been appointed to the newly created position of director of safety and inspection for Bethlehem Mines Corp., with headquarters in Johnstown, Pa. Since 1948 Wildey has worked in various positions in the mechanical department at the corporation's Marion Division, Fairmont, W. Va.

J. F. Wildey

Clyde Williams has resigned as president of Battelle Memorial Institute to form a new company. To be known as Clyde Williams and Company, the new group will provide services in research programming and administration, in the application of science and technology to industry, and in problems of business operation and organization. Williams remains a member of the board of directors of Battelle.

H. W. Strickland, vice-president in charge of the Houston office of Texas Gulf Sulphur Co., has been promoted to vice-president and general manager of the company. He fills the position vacated by **Claude O. Stephens** when the latter was elected president of Texas Gulf in March 1957.

On February 5 **Ernest J. Gleim** and **Eugene E. Quenon** were both awarded the Department of the Interior's highest honor, its Distinguished Service Award and Gold Metal.

Gleim, who spent 41 years in specialized research in coal-mine safety, retired in 1956 as Chief of the U. S. Bureau of Mines' branch of electrical-mechanical testing at Pittsburgh. He gained national and international recognition as an authority in examining mining equipment from the standpoint of safety.

Quenon received the award for 28 years of outstanding service in the Bureau's safety activities from his appointment as a first-aid miner in 1929 until the spring of 1957, when he resigned to join Peabody Coal Co.

George W. Streepey has been named assistant general manager of Aluminum Company of America's mining division. For the past four years, he has been production manager.

After joining Alcoa in 1920, Streepey became secretary and director for Alcoa Mining Co., a former subsidiary, in 1948. In 1952 he was made vice-president and director for the mining company, and in May 1954 was named mining division production manager.

Succeeding Streepey as division production manager is **Robert S. Overbeck.** He joined Alcoa's mining operations in the Dominican Republic in 1946. He also has served at Alcoa mining locations in Surinam.

Sheldon P. Wimpfen has joined Western Machinery Co. as general manager of its planning, research, and development department. Wimpfen had been vice-president of Glen Alden Corp. and before that had served as assistant director of the division of raw materials, Atomic Energy Commission, and manager of the AEC Grand Junction, Colo., office. He is also a one time editor of MINING CONGRESS JOURNAL.

S. P. Wimpfen

Ernest P. Hall has recently joined Pittsburgh Consolidation Coal Co. to become associated with **Henry Hebley** in work connected with the control of atmospheric and stream pollution. Before joining Pitt Consol, he was associated with the Mellon Institute.

Several organizational changes have been announced by the New Jersey Zinc Co.

W. L. Albers has been made general superintendent for Virginia. **Johnson Crawford** was made general superintendent for Tennessee.

C. G. Morgenstern succeeds Albers as superintendent of the Austinville, Virginia, operations, and **R. E. Radabaugh** was promoted from assistant to the western manager of mines to assistant manager of exploration. **F. H. Main** was also made an assistant manager of exploration.

J. I. Craig was named superintendent of the Flat Gap, Tenn., operations at Treadway, Tenn.

At the first of the year, **J. E. Osmanski**, manager of personnel for the operating department of Island Creek Coal Co. in Holden, W. Va., was promoted to manager of personnel for company-wide personnel activities. Osmanski, who will move his office to Huntington, W. Va., was succeeded by **R. E. Shelton.**

Vinton H. Clarke has resigned as vice-president in charge of mining and exploration of Howe Sound Co. to join the mining, geological and metallurgical consulting firm of Behre, Dolbear & Co., Inc. Clarke was associated with Howe Sound for over 20 years and during this period, contributed importantly to the development of its mining activities.

V. H. Clarke

Other changes at Howe Sound include the appointment as manager of mines of **A. G. Kirkland**, former manager of mines for the western operations of United States Smelting Refining & Mining Co., and the election of **W. Martin Fassell, Jr.**, director of research for Howe Sound, to vice-president of Calera Mining Co., a subsidiary.

A. J. O'Connor, vice-president and general manager of Consolidated Coppermines Corp., has been named president of the Nevada Mining Assn. He succeeds **F. A. McGonigle**, vice-president of Manganese, Inc.

Paul W. Feigley is the new vice-president and superintendent of the Beaver Coal Corp., West Virginia coal lessors. He succeeds the late **Paul B. Earwood.**

H. T. Middlebrook, surface superintendent of mining at Bauxite, Ark., for the Reynolds Metals Co., retired January 1. **J. A. Fuller** succeeds Middlebrook and **J. C. McFarlin** has been named assistant superintendent.

Charles E. Lawall retired at the end of January as vice-president of the Chesapeake & Ohio Railway. Chairman of the Mining Development Committee of Bituminous Coal Research, Inc., he announced that he will become a mining industry management consultant with offices in Huntington, W. Va. His duties with the C & O of supervising relations of the railway with the coal industry have been taken over by **Gregory S. DeVine**, a vice-president of the C & O.

C. E. Lawall

G. A. Engel, purchasing agent for U. S. Steel Corporation's Oliver Iron Mining Division retired at the end of 1957 following 41 years of service.

Lewis A. Parsons, consulting engineer for Calaveras Cement Co., recently was honored at a company luncheon in San Francisco in recognition of his formal retirement after twenty-one years on the Calaveras staff.

Parsons joined the firm in 1937 as mining and research engineer, and became consulting engineer in 1944. He was one of the originators of a new system of automatic kiln control placed in operation by Calaveras approximately four months ago.

John Wesley Smith, formerly preparation engineer for West Kentucky Coal Co., joined the Bell & Zoller Coal Co. in mid December as preparation engineer for all the company's properties.

F. A. Wardlaw, Jr., general manager, and **James J. Lillie**, assistant to the general manager, International Smelting & Refining Co., retired January 1 after veteran service with the wholly-owned subsidiary of the Anaconda Co.

F. A. Wardlaw

Wardlaw began his mining career back in 1912 when he joined Utah Consolidated Mining Co. as chief engineer and geologist. For the next two years he was mine foreman at Braden Copper Co. and served as superintendent of the Vipont Silver Mining Co. from 1919 to 1923. For the next six years he was superintendent of Utah Delaware Mining Co., and from 1930 to 1942 was general superintendent and assistant general manager, Inspiration Consolidated Copper Co. In 1943 he was made assistant manager, International Smelting and Refining Co., becoming general manager in 1944.

American Smelting & Refining Co. has announced the promotion of **J. F. Frost**, mining engineer, to manager of the western mining department, and **William P. Hewitt**, geologist, to senior geologist. They filled posts which were vacated January 1 with the retirement of **W. R. Landwehr**, chief geologist and acting manager of the mining department.

John A. Hagan has been appointed assistant to vice-president-operations of U. S. Steel Corp. He will be concerned with short and long-range planning for all mining and manufacturing facilities of the corporation on a nation-wide basis.

Alvin R. Rider has been named manager of Texas Gulf Sulphur Company's engineering department. Rider went to work for Texas Gulf Sulphur in 1950 and was made assistant manager of production in April 1957.

Uranium ore extraction and processing operation of Phillips Petroleum Co. have been placed under a newly formed mining and milling department with **T. M. Hipp** as manager. **Bradley Skinner** is technical assistant to the manager.

Also appointed to positions in the new department are **A. A. Ruoho**, general superintendent, and **R. W. Jenkins**, mines superintendent.

James P. Blaisdell has been named assistant manager of the Employe and Public Relations Division of Bunker Hill Co., Kellogg, Idaho.

Charles S. Bennett has been named superintendent of operations at the Kingsport, Tenn., plant of Penn-Dixie Cement Corp.

Two new vice-presidents have been elected by the directors of Utah Construction Co. They are **J. A. Mecia** and **C. W. Robinson**.

Mecia, who continues in charge of all of U-C mining activities in the United States, is vice-president and director of Lucky Mc Uranium Corp. Robinson formerly was U-C assistant secretary and assistant treasurer. He also is vice-president of Marcona Mining Co., Cia, San Juan, S. A., and Ocean Services, Inc.

L. L. Fusby was recently appointed vice-president, production, of Pacific Coast Borax Co. a Division of U. S. Borax & Chemical Corp.

On January 7, **Dr. A. K. Schellinger** joined the staff of M. A. Hanna Co. as a metallurgical engineer. He had been director of research and development for Cerro de Pasco Corp. and Professor of metallurgy for Stanford University. Schellinger will devote his time to the problems arising in connection with the treatment of Labrador-Quebec Iron Ore.

— *Obituaries* —

Carl C. Crowe, 61, secretary and assistant treasurer of the National Coal Association, passed away January 15 in Cleveland, Ohio, following a lengthly illness.

Charles Raymond Stahl, 77, retired labor relations manager for Eastern Gas & Fuel Associates, died December 24.

Mr. Stahl had been active in the coal industry for 48 years, and worked for Eastern Gas & Fuel Associates and its predecessors for 43 years. He started his mining career in 1898 in the engineering department of the Glen Alden Coal Co. In 1909 he went to West Virginia to work for the E. E. White Coal Co. as assistant engineer, becoming chief engineer in 1911 and assistant general manager in 1917.

When the organization was taken over by the Castner, Curran, and Bullitt Smokeless Coal Co. in 1925, he was made division superintendent. When EGFA purchased the operations in 1927, he became general manager of the CC&B division. In 1944 he became assistant to the vice-president in charge of accident prevention and labor relations. With the creation of the industrial relations department in 1951, the accident prevention department was made a separate division and Mr. Stahl was appointed labor relations manager. He retired from that position in 1952.

James Latimer Bruce, 78, vice-president and director of Cyprus Mines Corp., died February 6.

Born in Dublin, Ireland, Mr. Bruce received his mining education in this country and had wide experience in the west and midwest. From 1903 to 1913 he worked for several zinc and lead mining companies in the Joplin, Mo. area. Following that he was with the Butte and Superior Mining Co. of Butte, Mont., from 1913 to 1919; and with Davis Daly Copper Co., at Butte, from 1919 until 1924 when he became a consulting engineer. He had served as general manager, vice-president, and consulting engineer with Cyprus Mines Corp. for the last 33 years.

James W. Damron, 61, chairman of the board of the W. M. Ritter Lumber Co., and well-known for many years throughout the coal industry, died of a heart attack January 20. Mr. Damron was associated for many years with Red Jacket Coal Corp., and was chairman of the board of that concern when it was merged with Island Creek Coal Co., a few years ago.

Nickel Company Plans Hydrogen Sulfide Plant

Plans were recently announced for the largest synthetic hydrogen sulfide plant ever built. It will be a key unit in the $119,000,000 nickel-cobalt project being constructed in Cuba and in Louisiana by Cuban American Nickel Co., a subsidiary of Freeport Sulphur Co.

Cuban American Nickel has authorized the Girdler Construction Division of National Cylinder Gas Co. to engineer and equip an automatic plant to produce 60 tpd of liquid hydrogen sulfide for its ore-concentrating facilities at Moa Bay, Oriente, Cuba. The division is also engineering a plant to produce 1,500,000 cu ft of hydrogen per day as raw material for the hydrogen sulfide plant, and will provide storage facilities for hydrogen sulfide and for the liquid butane which will be raw material for the steam-hydrocarbon process hydrogen plant.

Cuban American's nickel refinery will be at Fort Nickel, La., near New Orleans. Its capacity will be 50,000,000 lb a year of nickel and 4,400,000 lb a year of cobalt when production begins in mid-1959. Limonite ore averaging 1.35 percent nickel and 0.14 percent cobalt will be mined near the Cuban plant at Moa Bay, where the ore will be concentrated by chemical means to produce a nickel-cobalt sulfide, to be shipped to the Port Nickel refinery.

A vessel will shuttle between the two sites, carrying sulfur and liquid butane to Cuba as raw material for the hydrogen and hydrogen sulfide plants being engineered by the division, and returning to Louisiana with the nickel-cobalt concentrate.

National Gypsum to Mine Asbestos

National Gypsum Co. has announced it will start mining asbestos in Quebec next summer and plans to sell about 25 percent of the output in Europe. The $5,000,000 plant now being built at Thetford Mines, Quebec, will be able to process 3000 tpd of ore. A large part of the output will be shipped to Gypsum's building materials plants, which now buy asbestos from other sources, to make shingles and wall siding.

This is Gypsum's first venture in the mining of asbestos and is also the first time the company has planned to sell any of its products in Europe.

Canada Extends Subsidy on Gold

Although federal subsidies to gold mines will be extended for two years, the Canadian government has not yet decided whether to boost the level of aid. Mines Minister Paul Comtois said requests by the gold industry and mining unions for bigger subsidies are still under study.

The aid program, begun in 1948, cost the federal treasury $9,300,000 last year. Subsidies were paid to 42 mines with total production of about 2,500,000-oz a year—more than half of the industry's 4,436,000-oz output.

Canadian mines receive the subsidy only if they sell to the government. They have the option of selling on the free world market. The subsidy is two-thirds of the production cost exceeding $26.50, with a maximum payment of $12.33 an oz. Payments are limited to two-thirds of a mine's output.

Coal Mine Is Closed

Lando Coal Corp. recently had to close its mine near Delbarton, W. Va., because the coal had run out. The mine began operating in 1922. According to one of the owners, the company will be liquidated and bids will be taken on the machinery.

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WHEELS OF GOVERNMENT

(Continued from page 80)

the Korean War and the stockpiles now held by the Government virtually eliminate the threat of raw material shortages of the type that hindered past defense mobilization efforts.

With respect to the maintenance of the mobilization base, the Committee said, "In some instances, stockpile procurement has been used to maintain essential productive capacity that had been threatened by economic problems. Procurement for the stockpile, however, is not necessarily either the best way or the only way of maintaining essential productive capacity. When maintenance of essential industry appears necessary, a plan should be developed to make appropriate use of each of the existing authorities of Government. These would include possible tariff adjustments, imposition of quotas, tax concessions, and the installation of Government-owned equipment in privately owned plants. If existing statutory authorities are inadequate, additional legislation should be requested. If stockpile procurement is used primarily to accomplish domestic or foreign economic objectives, such activity should be clearly explained to the public."

Gray has been asked by the Senate Interior Committee not to implement the recommendations until the Committee can review them in detail.

RAIL FREIGHT RATE BOOST GRANTED

Despite the determined opposition of the coal mining industry and others, the Interstate Commerce Commission permitted the Nation's railroads to make selective freight rate increases averaging 2 percent, effective February 14.

The additional burden on the already groaning coal mining industry is an increase of 10 cents per net ton on all-rail coal, and an increase of 8 cents per net ton rail transshipment rate to ports with a provision for 3 cents refund when there is a rail movement ex docks following water movement. The ICC also granted an increase of 8 cents per net ton on ex-river-rail movements, a 5 percent maximum increase in industrial switching charges, and a 10 percent maximum increase in the present charges for diversion and reconsignment.

The ICC will investigate the new rates for "lawfulness," and any increases found unlawful will be refunded to shippers.

INTERIOR DEPARTMENT FUNDS VOTED

Withholding the economy axe which it wielded last year, the House has voted $413,145,600 to run the Interior Department and related agencies during the fiscal year beginning next July 1—only $1,339,000 less than the President's budget request.

Unless the Senate runs counter to tradition by voting additional cuts, the money will be ample, according to Department spokesmen, to effectively carry on the work of the Office of Minerals Mobilization, Bureau of Land Management, Geological Survey, Bureau of Mines, and other Interior agencies.

In its report accompanying the bill, the House Appropriations Committee took another swipe at the ailing tungsten mining industry through the Defense Minerals Exploration Administration. "Despite the fact that the Government inventory of tungsten is far in excess of mobilization requirements," the report stated, "it remains on the list of commodities eligible for DMEA assistance and a new exploration contract was entered into as recently as December, 1957. The Committee sees absolutely no justification for additional expenditure of Federal funds for this purpose and directs that no additional tungsten contracts be approved."

Kentucky Coal Mine Planned

Plans for the opening of a new mine and erection of a modern coal preparation plant at Benham, Ky., were recently revealed by R. A. Lindgren, general manager of International Harvester Company's Wisconsin Steel Division. Preliminary mining and full-scale coking tests on the coal from the seams to be mined have been made, and have proved to be of excellent metallurgical quality.

Planned capacity of the mine, scheduled to be in full operation by early 1959, will be 4000 tpd. Link-Belt Co. has been given the contract for construction of the preparation plant.

Moose Mountain Taconite

The first taconite plant to be operated by M. A. Hanna is under construction at Moose Mountain, 35 miles north of Sudbury, Ontario. Work on the installation began in March 1957 and will be completed in May 1958. Outcrop ore will be mined by shovel and truck and processed by crushing, grinding and magnetic separation. When operating, the mine and plant will employ about 170 men.

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Concentrate Receipts Announced by AEC

The Atomic Energy Commission announced that domestic uranium concentrate production had reached an annual rate of 10,000 tons of uranium oxide (U_3O_8). Concentrates produced in the United States and received by the Commission during calendar year 1957, totalled 8640 tons of U_3O_8.

Included in this total are 146 tons which were produced as a by-product in the chemical processing of phosphate rock in Florida and Illinois; from the treatment of Idaho euxenite at the St. Louis plant of Mallinckrodt Chemical Company; and from reprocessing of refinery residues at Vitro Corporation's Canonsburg, Pa., plant.

Receipts by AEC from foreign sources were estimated at 11,826 tons U_3O_8, making a total for both domestic and foreign of 20,466 tons.

At the beginning of 1957, there were twelve operating mills in the western United States. Four additional mills came into production during the year.

Canadian Firm Plans Lithium Plant

Quebec Lithium Corp. of Montreal, recently disclosed that it would build a $3,000,000 lithium refining plant on a 450-acre site at Rouses Point, N. Y.

Lithium will be shipped to the plant from the corporation's mine at Val d'Or in northwest Quebec. This mine, 500 miles from Rouses Point, is rated as one of the largest lithium producers in the world.

The corporation will get power for its operation, which will be in full production by 1959, from the allocation Rouses Point is receiving from the St. Lawrence power project under contract with the N. Y. State Power Authority. Development of St. Lawrence power has been a factor in spurring industrial development in the area.

Du Pont Curtails Ilmenite Operations

Two ilmenite mines near Starke, Fla., owned by E. I. Du Pont de Nemours & Co., have been curtailed as the result of a lessening demand for titanium ore and zircon. The two plants, Highlands and Trail Ridge, normally employing about 250 men, will lay off 50 to 60 men, according to the company.

E. C. Weichel, Jr., manager of the plants, said the cutback in the Government's aircraft program in favor of missiles has reduced the demand for titanium metal used in jet planes. The Government is the largest user of titanium.

Du Pont has taken over actual operations of both plants, which have been operated in the past by the Humphreys Gold Corp.

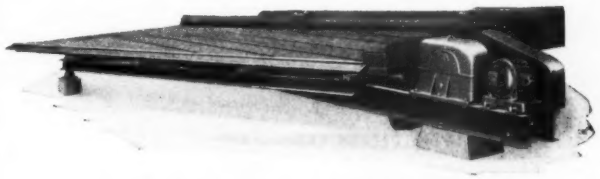
Haile Mines Buys Knitting Needle Stock

Haile Mines, Inc., recently bought the Government's interest in Karl Lieberknecht, Inc., with a bid of $2,766,000, according to the Justice Department. Lieberknecht of Reading, Pa., manufactures knitting needles. The United States seized 63 percent of the company's stock during World War II on the ground it was enemy held.

Haile Mines, important producer of manganese and tungsten, has been diversifying its interests.

West Germany Still Buying U. S. Coal

West Germany imported 16,000,000 tons of coal from the United States last year, the Association of Coal Importers of Hamburg estimated. Worth almost $238,000,000, the amount covered more than ten percent of West Germany's requirements of coal and coke. The association announced that American coal was still more expensive than German coal, but that price increases for German coal put into effect on October 1 and lower freight rates had narrowed the gap.



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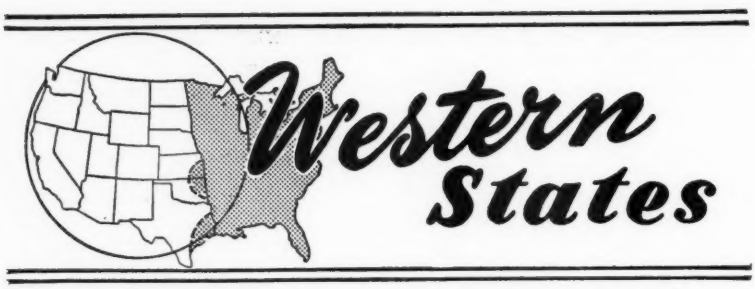

Chino Tops Its Safety Record

The Chino Mines Division of Kennecott Copper Corp. set a new safety record in 1957 with employes showing the lowest accident frequency rate in the history of the New Mexico copper property. In setting the mark, employes also began a series of consecutive days without a lost-time accident which remained unbroken at 80 days. November, 1957, was the first month in the division history in which no lost-time accidents occurred during a calendar month. This record was extended through December of 1957, and into January of 1958.

W. H. Goodrich, Chino general manager, said the new mark was set "as a result of employe interest and their cooperation in the division's safety program." Goodrich said Chino employes have participated in the operation of the company's safety program through various committees representing employes, unions and supervisory personnel. Increased use of protective equipment was encouraged during 1957. A number of employe suggestions for improvement of safe working conditions were received through the company's suggestion system.

Union Carbide Readies New Plant

The Green River, Utah, uranium ore upgrading plant of Union Carbide Nuclear Corp. is nearing operational status. A similiar operation at Slick Rock, Colo., in the Uravan mineral district is also in about the same stage of development.

The Green River plant will serve the general Temple Mountain uranium district where Union Carbide has operated mines obtained from the old Consolidated Uranium Corp. of Salt Lake City. The concentrator will have an input capacity of 300 to 400 tons daily. Circuits are designed to treat the carbonaceous ores of the Temple Mountain district and other type ores common to the general area around Green River.

The Slick Rock plant and a new uranium mill at Rifle, Colo., are referred to by the Atomic Energy Commission as the "Rifle Complex" of plants being built at cost of more than $8,400,000 by Catalytic Construction Co., Philadelphia, Pa.

Thorium Oxide Finds Market

Northwest Prospecting and Development Co. of Spokane made an intial shipment of thorium oxide concentrate to Heavy Minerals, Inc., in October. The concentrates were milled in Montana from thorite mined by the Spokane firm on Hall Mountain, north of Bonners Ferry, Idaho. Heavy Minerals tendered a proposal offering to buy for 1958 delivery, 100,000 pounds of thorium oxide in concentrate form containing at least 20 percent thorium oxide. This would require production of 500,000 pounds of concentrate.

Heavy Minerals is owned by Vitro Uranium, Inc., and the Crane Company.

Vitro Switches Processes

A $1,200,000 investment aimed at greater economy has resulted in switching from a phosphate precipitation process to a solvent extraction process at the Vitro Uranium Company's Salt Lake uranium mill.

This and other changes have increased the input at the mill from about 20 tpd in 1951 to about 600 tpd now. The company has virtually rebuilt the wartime alumina plant. Sufficient machinery and space for eventual processing of other ores and strategic minerals, however, still exist.

Daybreak Goes Underground

Conversion to underground mining methods has been started by Daybreak Uranium, Inc., at its open-pit operation in northeastern Washington.

An incline will follow the main mineralized zone at an angle of about 15 degrees. The change of mining is necessary because of increasing overburden as the vein dips into the hillside.

In 18 months the mine has produced and shipped 12,000 tons of ore and moved about 75,000 tons of overburden.

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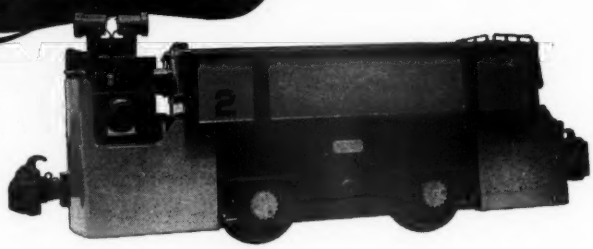

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LOOK AHEAD TO SAN FRANCISCO

SEPTEMBER 21 to 25 should be blocked off on the calendars of all mining men as the dates of the 1958 Mining Congress Convention and Exposition in San Francisco.

Keen interest in this meeting has already been expressed by mining executives, engineers, operating men, legislators, Government officials and educators, and registration is expected to be at an all-time high. The exhibits of mining equipment will be larger and more varied than ever, with more space already under contract than in any previous year.

Work on the program, already begun, will reach peak intensity early in the summer when State Chairmen will meet to review the industry's problems. Policy and economic matters will undoubtedly receive special attention at the convention as prominent national figures discuss the difficult and changing situations in various branches of metal mining and industrial minerals production. The program will also include a full schedule of operating sessions, dealing with practical problems of underground and open-pit mines, quarries and mineral beneficiation plants.

Besides all of this attention to the serious business of mining, plans have been made for a number of social events, including the traditional Miners Jamboree at the historic Palace of Fine Arts and the AMC Dinner Dance at the Sheraton Palace Hotel.

The ladies' events, which are particularly interesting and well planned, will include a reception and tea at the Alta Mira Hotel in Sausalito, a luncheon at Castlewood Country Club in California's wine country, and a glamorous Fashion Luncheon at the stately Fairmont Hotel. Many of the ladies, as usual, will also visit the magnificent exhibits of mining equipment and attend some of the convention sessions.

On Friday following the meeting, there will be another Salmon Derby, and field trips to a number of industrial plants down the Peninsula from San Francisco—Kaiser's Permanente Cement plant, the new Ford Motor Co. assembly plant, Stanford Research Institute, the electronic and scientific equipment plant of Hewlett-Packard Co., and the publishing plant of Sunset Magazine. Still another group will make the short air hop to San Simeon, the twenty-five million dollar "Arabian Nights" estate of William Randolph Hearst.

San Francisco mining people are preparing to roll out their finest welcome mat, and their city certainly has the facilities to do a bang-up job of it. You are urged to make your plans early. Send in your request for hotel reservations to the American Mining Congress Housing Bureau, Room 300, 61 Grove St., San Francisco, Calif.

Safe Year for Colorado Coal Mines

The year 1957 was the first in the history of the Colorado coal mining industry in which there were no fatalities in the mines, according to Thomas Allen, State coal mine inspector. Allen attributes the lack of fatalities in 1957 and the fact that there have been 14 consecutive months without a death in the coal mines to better safety methods, better inspection and the cooperation of all people in the industry, including labor. Estimated coal production for the year was 3,460,000 tons.

Potash Mine Passes Milestone

International Minerals and Chemical Corp. recently hoisted the 30-millionth ton of sylvite ore from its potash mine near Carlsbad, New Mexico.

The mines started production in October, 1940, in the sylvite ore bed which is common to all potash mines in the Carlsbad area. Besides sylvite (potassium chloride) however, IMC mines langbeinite (potassium magnesium sulphate).

The estimated capacity of the mine was 1800 tons per day when production first started, but now, due to expansion and modernization as much as 14,464 tons have been hoisted in one 24-hour period.

Homestake Developing Wyoming Property

Homestake Mining Co. is sinking a 400-ft shaft for mining uranium ore in Crook County, Wyo. Completion is expected by April. Ore will be mined from the Black Hills Hauber ranch, 40 miles north of Moorcroft, and shipped to Mines Development's mill at Edgemont, S. D. Homestake first discovered uranium on its holdings in May 1953 and a deep drilling program in 1956 proved substantial subsurface deposits.

Ships Autunite Ore

Clayloon Uranium Co. made its first shipment of autunite ore from the Huffman lease in the Mount Spokane district of northern Spokane County, Wash. Approximately 500 tons of ore mined and stockpiled at the property was trucked to Dawn Uranium Company's processing plant at Ford, Wash. Clayloon is operating the property under an agreement with Daybreak Uranium, Inc. Production to date has been by open-pit methods from a vein structure associated with the fault, according to Byrl T. Goodwin, president of Clayloon, but future mining operations will probably have to be carried out by underground methods.

Sabre Opens New Mexico Mine

Sabre Mining Co. of Lordsburg, N. M., headed by Donald L. Nett, recently opened a gold-silver-lead underground mine south of Lordsburg in Grant County. The operation is known as the Rattler Mine.

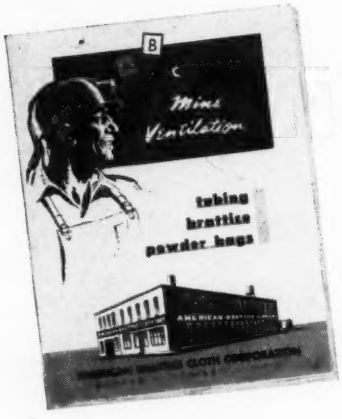
Boron Rush On

The stage is being set for a new mining rush in the Mojave Desert, with the emphasis on borates and other nonmetallic minerals. One of the big causes of this rush is the sudden widespread interest in boron fuels to power missiles and rockets.

Kern County Land Co. has signed up acreage in the Kramer mining district northeast of Boron, Calif. In another negotiation, M. E. Frazier of Los Angeles and Finley Co. of South Houston, Texas, leased from Mineral Materials Co. two placer mining claims totaling 180 acres about three miles north of Boron.

Neither of these leases, though, was comparable in size with that consummated several months ago by Kerr-McGee Oil Industries, Inc., and Southern Pacific Land Co. Kerr-McGee, a major midcontinent oil producer, signed up 14,885 acres in Kern and San Bernardino Counties. Much of the acreage is in the Boron area.

We have reserved a copy of our new 24-page CATALOG for YOU!



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Kennecott Buys Consolidated's Nevada Mines

Consolidated Coppermines Corp. announced the sale to Kennecott Copper Corp. of all its copper mining properties and equipment in White Pine County, Nev., for $8,400,000. Kennecott took possession February 1.

J. C. Kinnear, Jr., general manager of Kennecott's Nevada Mines division, in Ely, Nev., said the sale to Kennecott includes Consolidated Coppermines' Tripp pit, its contiguous holdings in Kennecotts' adjacent Liberty and Veteran pits, as well as numerous mining claims, water rights, equipment and other items at the Nevada property. Kennecott Coppermines and their predecessors have worked side by side at Ruth and Kimberly, Nev., for 50 years.

At present, Coppermines' production has been averaging 9000 tons of ore a day, with 7000 tons coming from the Tripp pit and 2000 tons of ore daily mined by Kennecott for Coppermines' account in adjoining claims in the Liberty and Veteran pits. Kennecott's production from its own Nevada mine has been approximately 12,000 tons a day. Kennecott said it will continue to process 21,000 tons a day. Operations will be intensified at the Liberty and Veteran pits to make up for ore previously supplied by Coppermines' Tripp pit. The latter will be inoperative for a period, while the new procedures and mine schedules are being planned.

Bretz Mercury Mine Considers Expansion

A unique mercury mine and reduction plant in southern Oregon has completed nearly a year's operation and the operators are now considering substantial expansion in processing lower grade ores. Operators at the Bretz Mercury Mine on the Nevada-Oregon border, about 40 miles west of Idaho line, are "Arentz-Comstock Venture" of Salt Lake City.

Since its discovery in 1931 the ore body has been mined off and on as the demand for mercury warranted. After the initiation of the government's stockpiling program in 1954 additional exploration was carried on which resulted in the discovery of ore a few feet below the bottom of an old open-pit exploration project.

Stripping at the Bretz mine was started in April 1956 and construction of a flotation plant began on August 1. Utilization of flotation on mercury is unusual in western quicksilver operations. Dissemination of the mercury values for example, in other mines in the Bretz area makes fine grinding necessary and flotation too expensive. At the Bretz, however, the values appear in the interstices around the hard opalite mineral so that there is a good separation under crushing of the fine material.

Montana Iron Ore Operation Set

Minerals Engineering Co. of Grand Junction, Colo., has negotiated an agreement with North American Utilities Corp. of Montreal, Canada, for construction of an $8,000,000 iron ore concentrator near Dillon, Mont., according to R. N. Roby, exploration engineer for the Colorado firm.

The plant will process iron ore from a deposit of magnetite which Minerals Engineering uncovered in the Carter Creek area last past year.

North American utilities will provide the funds for the plant and for working capital, and Minerals Engineering will be the operating company, Roby stated.

Present plans call for a mill that will handle about 3000 tons of ore daily and turn out about 1000 tons of pellets or concentrated iron ore per day for shipment to a steel mill that is to be built in Canada, he added.

Tungsten Production in Tin Smelter

Tungtsen production may begin soon in the old tin smelter at Texas City, Texas. Wah Chang Corp. of New York, bought the plant from the Government several months ago, and has been remodeling the smelter for tungsten operations.

Some of the persons formerly employed by the government will be reemployed when the smelter is ready to go into the production of tungsten.

Automation in Cement Production

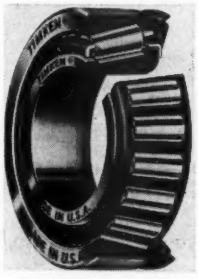
The Calaveras Cement Co. in San Andreas, Calif., has installed a completely automatic system of kiln operation. The system has been in operation for several months. The company's steps toward perfecting a sensitive complex of instruments to regulate its 360-ft long revolving fifth kiln has been watched closely in the cement industry, which regards the control system as a major move toword automation in the manufacture of cement.

A method of measuring the temperature of the mix in the calcining zone of the kiln, approximately 110-ft from the start of the burning zone, has been provided for the first time. Temperatures in this area average 1400°F. Changes in mix temperature, as noted by the instruments, bring about immediate compensating changes in fuel and air flows to keep the burning process uniform. Until now this phase of cement manufacture has required the attention of an operator skilled in estimating temperatures in the calcining area by comparing the recorded temperatures at feed and burning ends of the kiln. The operator would then make manual adjustment of fuel and air flows. The new system of precision control makes possible a uniformity of production not previously attainable.

Manufacturers Forum

Seal

THE SYNTHETIC Duo-face seal combines the features of the outside diameter seal and the face type seal, according to the Timken Roller Bearing Co., Canton, Ohio. One lip operates in the bearing housing bore providing an outside diameter seal. The other lip operates against the smooth, flat, hardened and ground face of the bearing cup providing face type sealing. The Duoface seal is supplied pressed onto the Timken bearing cone and is currently available on seven different sizes of bearings. These are by bore sizes: 0.750, 0.8437, 1.000, 1.250, 1.375, 1.500 and 2.6875 in.



Inquiries about new equipment appearing in Manufacturers Forum are welcomed. For additional information on any piece of equipment in this section write directly to the manufacturer, or to Mining Congress Journal with name of item and date of issue in which it appeared.

Air Compressor

AN INTERMEDIATE SIZE air compressor, the AR-3, has been added to the stationary compressor series of Atlas Copco Eastern, Inc., Paterson, N. J. The AR-3 has a free air delivery ranging from 570 to 680 cfm at 100 psi and is available either for permanent installation or as a skid-mounted unit. It weighs 5400 lb and measures 60-in. deep, 41-in. wide, and 72-in. high. The AR-3 is also available through Atlas Copco Pacific, Inc., of San Carlos, Calif.

AC-DC Electrode

A CHROMIUM-NICKEL ac-dc electrode meeting specifications MIL-E-6844-E, AMS-5785-B and MIL-E-16715-A has been announced by All-State Welding Alloys Co., Inc., White Plains, N. Y. It is recommended by the manufacturer for high alloy steels, tool and spring steels, pressure vessels, air hardenable steels, dies, nickel clad and mild and medium carbon steels.

As welded properties include: tensile strength, 120,000 psi; elong. in 2 in., 35 percent; and hardness, 200 Brinell. Deposits cannot be heat-treated, but can be work-hardened to over 180,000 psi tensile.

Designation for this electrode is All-State No. 275—the number carried since December 1954 by its predecessor. The new No. 275 uses the same core wire as the old, is characterized by the same low amperages and is available in the same sizes. Difference is in the coating and its greater dependability for prosity free, dense deposits with little or no spatter. Manufacturer of the old No. 275 has been discontinued.

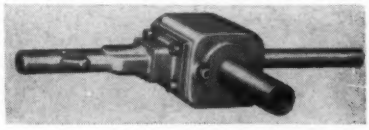
Hopper Carrier—Forklift

ABILITY TO CARRY 3000 lb in an 18 cu ft hopper or when used as a platform carrier is one of the features claimed for the Kwik-Mix Moto-Bug. As a forklift (at 15-in. load center) this model reportedly will raise 1500 lb. to 7 ft. Operator can tilt the forklift mast 10° back—2° forward. A direct drive to the power flow transmission eliminates shifting and allows a 12 mph forward or reverse speed. Electric starting and L. P. gas equipment are optional.

Complete information on the model, designated the R-18, can be obtained from Kwik-Mix Co., Division of Koehring Co., Port Washington, Wis.

Hydraulic Coal Drills

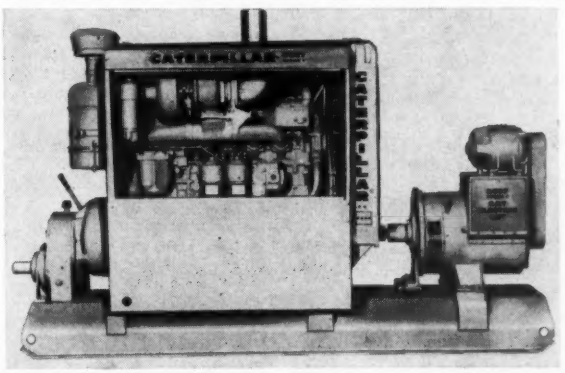
MADE OF ALUMINUM and designed to operate at 2000 psi, the Model 1-M-20 and Model 1-M-30 Hydraulic Coal Drills combine light weight with high horsepower to permit one man to do the work formerly



requiring two men using heavy mounted drills, according to the Long Co., P.O. Box 331, Oak Hill, W. Va. Both models operate at the same pressure and gallonage and can be interchanged at the face. The 1-M-20, weighing 20 lb, is designed for drilling all powder holes, while the 30-lb Model 1-M-30 is said to be particularly applicable for Airdox and Cardox holes.

Drive Unit

DESIGNED TO HANDLE PLANTS in the 150 to 200-ton class, the Caterpillar D337 (Series F) electrical and mechanical Drive Unit, combines the advantages of both types of drive for crushing plants, according to Caterpillar Tractor Co., Peoria, Ill. The unit simultaneously provides mechanical operation for crushers and electricity for flexible control of conveyors. It supplies variable horsepower through a reduction gear at the end of the crankshaft and 60 kw from a generator mounted on the front. The Cat 337 (Series F) diesel engine that powers the Drive Unit is rated at 230 brake hp at 1800 rpm. Specifications for the Drive Unit are: Length, 136½ in.; width, 45 in., and height about 80 in.



Power Loader

A FRONT-MOUNTED power loader for use on International 330, 300, and 350 Utility tractors has been announced by International Harvester Co. Known as the McCormick U-34B Power Loader, it can be powered either by the tractor's Hydra-Touch hydraulic system or with a front-mounted hydraulic pump.

A variety of interchangeable attachments adapts the loader to many loading, lifting, grading and material-moving jobs. These include a standard nine cu ft material bucket, a six-tine fork, and a tine cover that converts the fork into a nine cu ft material bucket. A crane attachment, and a seven-ft leveling and grader blade also can be used on the loader booms.

While regularly equipped with manual bucket control, the U-34B can be fitted with a two-way cylinder for hydraulic bucket control.

Roof Bolt Suspension Arm

THIS DETACHABLE suspension arm, when inserted into a dual purpose roof bolt washer plate, is said to provide ample suspension for trolley cables, drainage tubes, ground wires and any hangable accessory. Further data may be obtained from Connors Steel Division, H. K. Porter Co., Inc., P. O. Box 2562, Birmingham, Ala.

Scraper

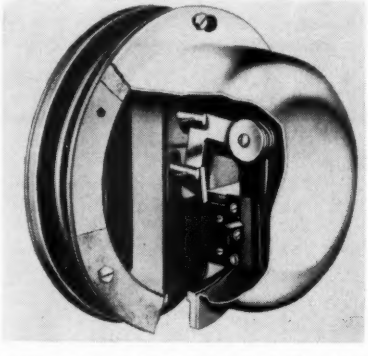
AN 18-CU YD scraper for use with tractors of 90 or more horsepower, the CT Scraper is a four-wheel version of the Fullpak design pioneered in the firm's B and C Tournapull scrapers. Features claimed include: A clean smooth bowl interior for minimum resistance in loading and unloading, a 9½-ft three-section blade angled precisely with the floor to further combat loading resistance, and a specially curved deflector plate and anti-spill grid on the top of the tail gate structure to provide maximum "roll" and "boiling" action in the loading process.

For additional data write LeTourneau-Westinghouse Co., Department 085, 2301 N.E. Adams St., Peoria, Ill.

Bin Level Indicator

IMPROVEMENTS in the Bin-Indicator—automatic bin level indicator and control unit—have been announced by The Bin-Dicator Co. Most significant change is a twist lock cover. This design has no nuts or bolts which can drop. It incorporates slotted hex-head screws which need only to be loosened so that the cover can be turned and lifted, exposing the operating mechanism.

Another reported improvement in the Bin-Dicator is a vented housing that permits a more sensitive and reliable operation. This vent relieves



any pressure build-up in the housing as the diaphragm is flexed in response to the pressure of the material in the bin, silo, hopper or chute.

New construction features claimed include: a drilled and tapped frame for assembly of cover, drilled and tapped frame for assembly of diaphragm and diaphragm retainer ring, and a diaphragm assembly which has perforated mounting holes to simplify replacement and/or change of diaphragm if required.

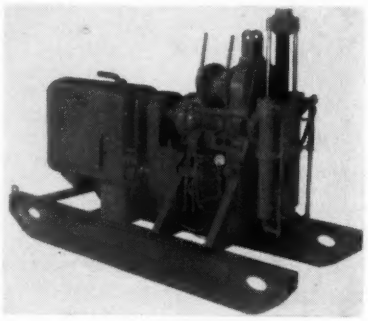
For information on the Bin-Dicator, write The Bin-Dicator Co., 216 13946 Kercheval Ave., Detroit 15, Mich.

100-Ton Hydraulic Ram

WEIGHING 265 LB, a 100-ton hydraulic ram has been added to the Simplex Re-Mo-Trol line of Hydraulic Center Hole Pullers by Templeton, Kenly & Co., Broadview, Ill. The Model RC-1122 Ram has 22 in. of travel and can be operated by hand or power pump adjacent to the work or at a remote point. The ram can be rigged for pulling through center hole or for pushing. Over-all minimum height is 33 in.; housing diameter is 7½ in.

Core Drill

POWERED BY A 134 CU IN. 30-HP liquid cooled gasoline power unit, the Model JS Core Drill has been developed by the Penndrill Manufacturing Division of the Pennsylvania Drilling Co., 1201 Chartiers Ave.,



Pittsburgh 20, Pa. The drill reportedly is designed with a low center of gravity and wide skids to offer maximum stability when drilling in rough terrain. It incorporates an integral 20-ft aluminium derrick and optional cathead, and is offered with either an AW or NW 24-in. feed hydraulic swivel head capable of handling the Diamond Core Drill Manufacturer's Associations W series drill rods.

Industrial Radiography Unit

A PORTABLE, industrial radiography unit (MG 100), which is said to provide sharp radiographic detail

and exceptional penetrating power, has been announced by the Instruments Division, Philips Electronics, Inc., 750 South Fulton Ave., Mount Vernon, N. Y. The unit reportedly is powerful enough for tasks involving steel welds and opaque materials such as aluminum, magnesium, rubber, plastics, glass and food products.

—*Announcements*—

Charles P. Read, a vice-president of **Heyl & Patterson, Inc.**, contracting engineers of Pittsburgh, Pa., was honored at a Testimonial Dinner, January 25 on the occasion of his

H&P president Harry R. Edelman, Jr., (right) presented a plaque to Charles P. Read

60th anniversary of continuous service with the company.

Harry R. Edelman, Jr., president of Heyl & Patterson, in his congratulatory address stressed the fact that Charley Reed is not retiring but continuing in full time active service.

Charley Reed attributes his remarkable achievement to a life-long dedication and love for his work and a never ending interest in the new challenges and opportunities that came his way.

Jerome V. Sparapani has been named an erecting engineer for cement, crushing and mining machinery by the service section of **Allis-Chalmers Mfg. Co.**

The appointment of **Harold E. Boncutter** as advertising manager of **Hercules Galion Products, Inc.**, has been announced. Before his recent promotion, Boncutter was associated with the **Battelle Memorial Institute** as an administrative and public relations assistant. Before that he had been advertising manager of the **Marion Power Shovel Co.**

James A. Nissen has been appointed general sales manager for **Denver Equipment Co.** Nissen had been president of his own company, which he organized in 1948 for the sales of mineral processing equipment and the design and construction of mills.

Dorr-Oliver Incorporated has announced the retirement of **Frank H. Conover**, director of the FluoSolids Technical Division. The company also announced the reorganization of that group and FluoSolids Sales into a new overall FluoSolids Division with **Robert B. Thompson**, former FluoSolids sales manager, director of the combined division.

Nordberg Manufacturing Co. has announced the appointment of **Robert E. Luebke** as a sales engineer in the Mining, Crusher and Process Machinery Division.

Vulcan Iron Works Co., Denver, Colo., has announced the appointment of **John H. Jett** as vice-president and general manager. Jett has served as acting general manager since October 1, 1956. He came to Vulcan as a sales engineer in 1954 from the mining division of the Atomic Energy Commission.

Harvey C. Shaughency has been appointed sales manager for the **Thompson-Berg Co.** of Iron Mountain, Mich. The company is a newly formed affiliate of the **W. B. Thompson Co.**, distributor of mining equipment and accessories.

Prior to joining Thompson-Berg, Shaughency was associated with the **Sullivan Machinery Co.** and its successor, the **Joy Manufacturing Co.** in the Pittsburgh, El Paso and Duluth districts from 1929 to October 1957.

John A. Wettergreen has been named manufacturing vice-president and general works manager of **Marion Power Shovel Co.** He succeeds **Martin R. Tuttle** who resigned. Before taking his new position, Wettergreen was vice-president and in charge of manufacturing for the **Bucyrus-Erie Co.**

J. W. Hardesty has been appointed general manager-sales of the Construction Equipment Division, **Baldwin-Lima-Hamilton Corp.**, Lima, Ohio.

W. Herman Van Houten has been appointed assistant to the president of **Joy Manufacturing Co.** He also was named a director and vice-president of Joy's Mexican subsidiary. Formerly sales manager, renewal parts, Von Houten has been with the company since 1934.

Gerald C. Nalon has been appointed sales representative for the Mining Sales Section of Metallurgical Products Department of the **General Electric Co.**

J. R. Grizzle, sales manager of Yuba Manufacturing Division, **Yuba Consolidated Industries, Inc.**, since May 1957, has been appointed director of sales for the Yuba Mining Division.

CATALOGS & BULLETINS

CONE FILTERS. *Carpco Manufacturing, Inc., Jacksonville 6, Fla.* Design, construction and operating data on cone type filters being manufactured by Carpco are given in Bulletin CFB-101. Brochure describes the characteristics of this machine in discharging dewatered, granular material at constant moisture content. Carpco dewatering cone filters employ a revolving steel cone covered by a perforated disk and filter cloth. A vacuum within the cone draws water from a bed of material which is continuously fed onto the filter surface. Dewatered material is discharged by a stationary plow. The machine is currently being produced with a six ft diameter cone, but larger sizes with greater capacities are built on order to suit customer's requirements.

TWIN-BEARING SCREENS. *Screen Equipment Co. Inc., Buffalo 25, N. Y.* Booklet TB-21 describes Seco Twin-Bearing screens. This line of two bearing models is offered in single deck construction in 3 by 6 ft to 6 by 16 ft sizes; double deck, 3 by 6 ft to 6 by 16 ft; triple deck, 3 by 6 ft to 6 by 12 ft. Special models with half-decks (up to 3½ decks) are also available. Dust housed models can be made to order. Screens can be equipped with electric wire cloth heaters for screening fine, damp or sticky materials. The Twin-Bearing screens are equipped with all the necessary fittings for cable suspension, for base mounting, a special factory designed mounting is available.

LIQUID RHEOSTATS. *General Electric Co., Schenectady 5, N. Y.* Two bulletins dealing with liquid rheostats are now available. One of the publications, designated GEA-6664, discusses applications of liquid rheostats to provide stepless secondary control of high-horsepower wound-rotor motors such as those used by utilities, steel mills, dredges, wind tunnels, mining, and pumping stations. The second publication, GET-2740, is more technical in nature. It describes operating characteristics of liquid rheostats in various applications, provides performance curves, and discusses design of the units.

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TRACTOR GROUP EQUIPMENT. *Construction Machinery Division, Tractor Group, Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.* Allis-Chalmers is offering several pieces of literature covering Tractor Group equipment. "Accessories and Attachments for Allis-Chalmers Motor Graders" (MS-1161) serves as a handy reference to owners and users of the Allis-Chalmers Model 45 and Model D motor graders. The company's pocket-sized line catalog (MS-1272) has been revised to include its turbocharged HD-21 diesel powered crawler tractor and the TS-160 motor scraper. Each unit in the line is pictured in the booklet which gives information about the size, capacity, weight, horsepower and other pertinent facts of each unit. The firm's B-125 power unit is described in catalog (MS-1247). Included are B-125 specifications and a list of special equipment available to expand the versatility and use of the engine.

ALCO PRODUCTS REVIEW. *Alco Products, Inc., P. O. Box 1065, Schenectady 5, N. Y.* Articles describing the company's new nuclear research laboratory at Schenectady and heat transfer engineering feature the winter issue of this 26-page publication.

CENTRIFUGAL PUMPS. *Ingersoll-Rand, 11 Broadway, New York 4, N. Y.* Flier describes Ingersoll-Rand's centrifugal pumps designed for continuous operation within the medium pressure range. These pumps—the RT, RTS and RTL units—are meant for general hydraulic service. They are horizontally-split, single-suction pumps built with three, four, six or eight stages for capacities from 200 to 2800 gpm. Pressures go up to 1200 psi and heads range between 460 and 2400 ft. Ask for Form 7148-A.

CAR RETARDERS. *Union Switch & Signal, Division of Westinghouse Air Brake Co., Swissvale, Pa.*. Bulletin 173 describes Union Electro-Pneumatic Car Retarders for industrial applications.

TRANSFORMER ENGINEERING MANUAL. *R. E. Uptegraff Manufacturing Co., Scottdale, Pa.* Bulletin 137 describes four series of dry-type distribution transformer. Data on these four series are included: (1) 3 to 10 kva, class H insulation; (2) 15 to 112½ kva, class H insulation; (3) 3 to 112½ kva, class B insulation—silicone impregnation for moisture repellence, non-deterioration and additional overload capacity; (4) 150 to 500 kva, class B insulation.

TREATMENT OF MINE DRAINAGE WATER. *Saverite Engineering Co., 158-14th St., Hoboken, N. J.* Chemical methods for purging and maintaining mine drainage and coal preparation plant process water are covered in this publication. Saverite Engineering Co. reportedly has also successfully extended its treatment to the water cooling systems now employed by many of the continuous mining machines. Simplified water analyses and application methods are part of the system and can be used effectively by the mine operator for determining the extent of treatment required, according to the company.

FLEXIBLE COUPLINGS. *T. B. Wood's Son's Co., Chambersburg, Pa.* Bulletin No. 10100 tells how to select Sure-Flex couplings suited to more than 150 different service applications. Five tables short-cut the usual engineering calculations and quickly give the right answer, taking into consideration the type of driver, horsepower and rpm as well as the specific application. This patented flexible coupling consists of two flanges and a two-piece rubber sleeve, which lock together without clamps or screws. The product is said to be designed to withstand all combinations of misalignment and end float and will absorb up to 15 degrees of torsional shock.

COST RECORD BOOK. *Sales Promotion Department, The White Motor Co., Cleveland 1, Ohio.* The 36th annual edition of White Motor Company's Cost Record Book for truck fleets, revised for modern fleet cost practices, available to fleets and all truck operators.

CASTINGS. *Nordberg Manufacturing Co., Milwaukee 1, Wis.* The story of Nordberg quality Ni-Hard castings is contained in Bulletin 263. This nickel-chromium white cast iron reportedly has outstanding abrasion resistance. Wearing parts for many types of machinery are produced in the Nordberg foundry, which has facilities for pattern making, casting and quality control throughout the production process. Photographs of these facilities are shown as well as photographs of a variety of finished castings. The physical and chemical characteristics of Ni-Hard and a conversion chart for comparison of the various recognized measurements of hardness are included in the brochure.

ROTARY KILN. *Vulcan Iron Works, Wilkes-Barre, Pa.* Entitled "A New Concept in Rotary Kiln Design," this brochure illustrates and describes Vulcan's new concept in rotary kiln design. It is claimed that this rotary kiln will simplify foundation plans, avoid frictional wear, reduce torque and power load, save maintenance costs and occasion less downtime.

A-C MOTORS. *Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio.* Reliance Totally-Protected A-C Motors from 1 through 125 hp are discussed in Bulletin B-2506. Photos, drawings and text explain total protection and its importance to motor performance. Also described is availability of NEMA large frame a-c motors and their modifications.

TECHNICAL DATA CATALOG. *Lefax Publishers, Philadelphia 7, Pa.* Lefax Publishers has announced a newly revised catalog for 1958 of Lefax Pocket Size Technical Data Books, selling at $1.25 each. These books, said to cover every field of engineering, contain about 140 loose leaf pages of up-to-date material. Partial List includes: Metallurgy, Mining Geology, General Math, Conversion Tables, Chemical Tables, Physics, Mechanics of Materials, Physical and Thermodynamic Tables, Steel Forms & Shapes. Catalog sent free.

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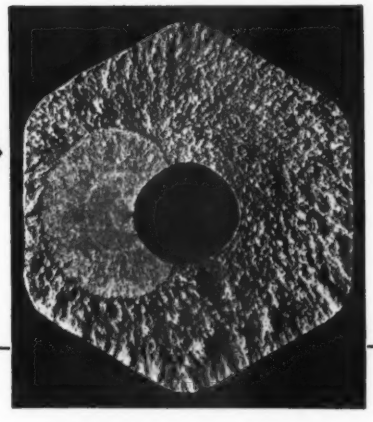
The steel with up to 50% longer life!

New anti-corrosion treatment stops premature breakdowns such as this



On untreated drill steels corrosion sets in early around the flushing hole, wearing out the steel before its time.

Corrosion has been responsible for the premature breakdown of untold numbers of drill steels. Now, from Sandvik, the world's largest manufacturers of integral steels, comes a new 'Coromant' steel well and truly protected against it. Those who have already tried out Coromant SR-treated steels report that their resistance to corrosion lengthens their life up to 50%.

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To complete the protection of the steels during transport and storage, Sandvik Coromant SR-treated steels are fitted with air-tight plastic caps on both the bit and collar.

Sandvik Coromant SR-treated steels are another step towards lower drilling costs. When fitted to an Atlas Copco rock drill you have an unbeatable drilling unit, for both were developed to work together. No drill or steel developed separately could ever give such equivalently high performances. In ten years Atlas Copco drills and Coromant steels have become the world's most widely used drilling unit, responsible for the drilling of no less than one billion feet per year.

Sandvik Coromant SR-Treated Steels

Write, phone or cable today for further details to any of the addresses below:

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